Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

SEPTEMBER 1954

VOLUME 37 • NUMBER 9

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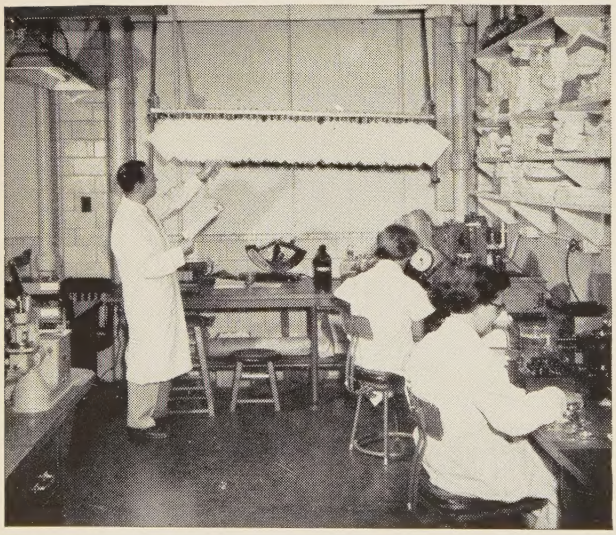

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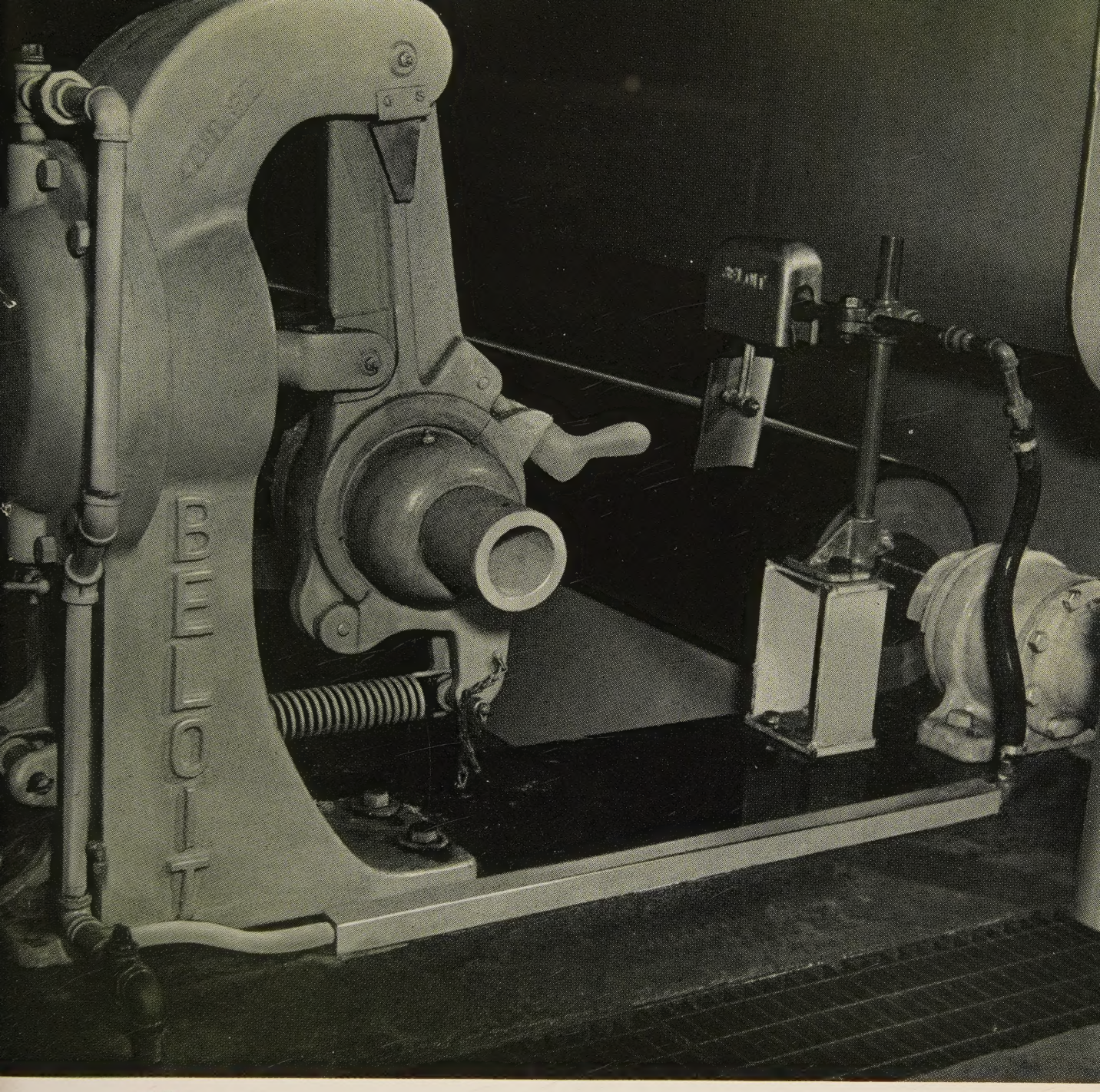

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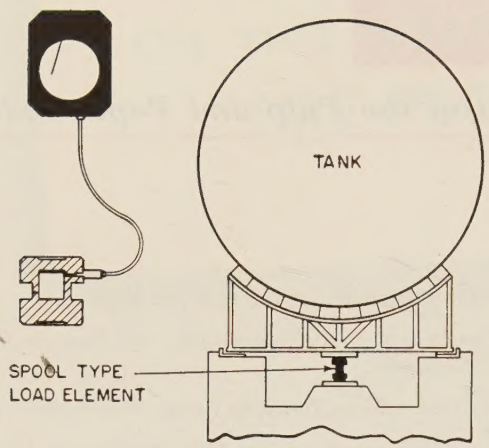
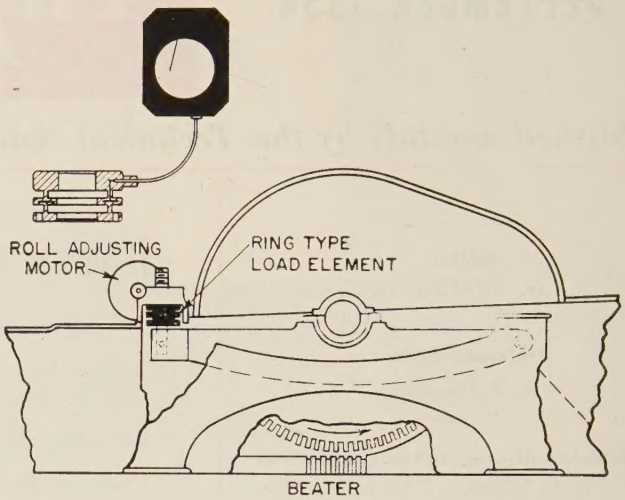
How to solve weighty





Spool Type Load Measuring Element

Problem: to accurately measure the weight of corrosive liquors in tanks.

Solution: Taylor Spool Type Load Measuring Element. Applicable to both horizontal and vertical tanks. Range limits 0-400,000 lbs. for compression loads. For tension loads 0-30,000 lbs.

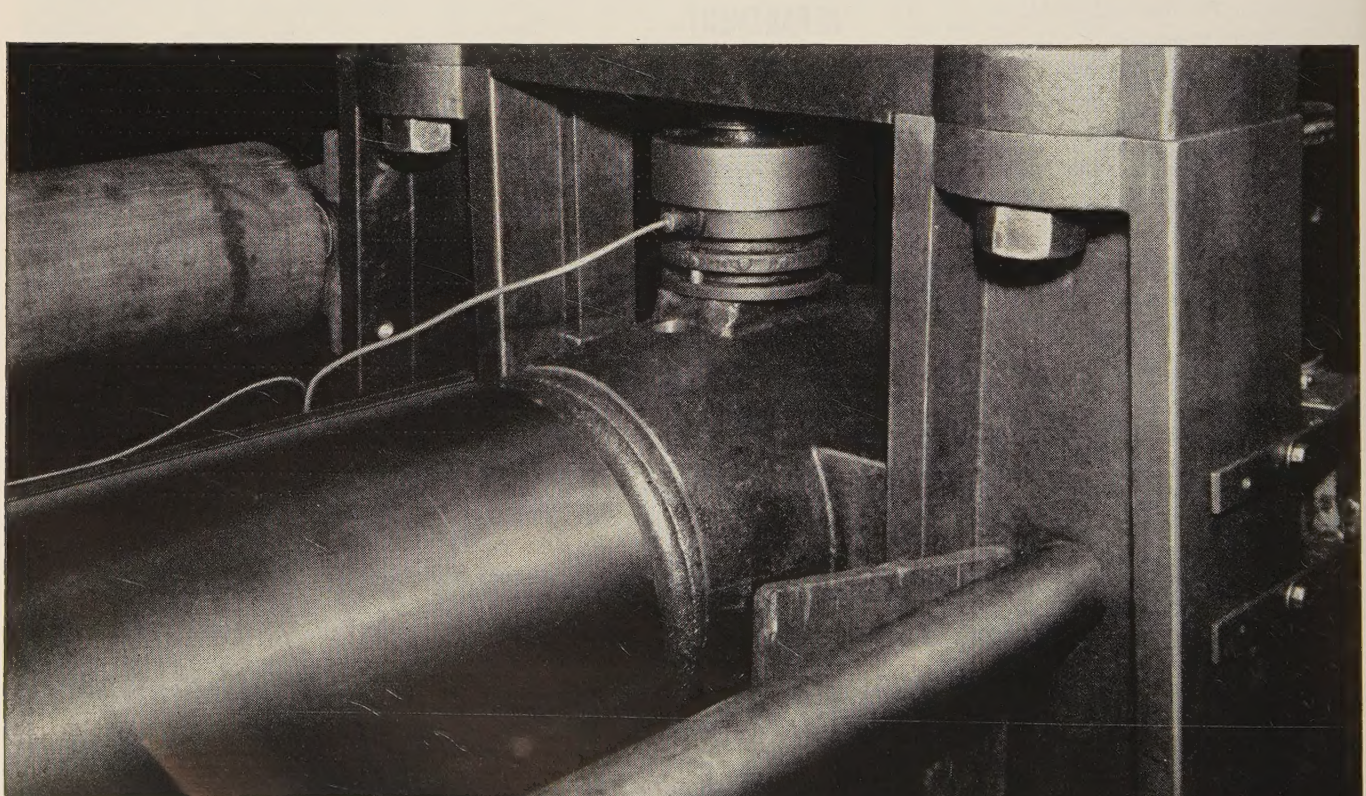
Results: a practical and trouble-free measuring system for an application that makes conventional liquid level measuring devices impractical. Also recommended for liquids with suspended solids.

Ring Type Load Measuring Element

Problem: to accurately measure processing pressure in a paper stock beater.

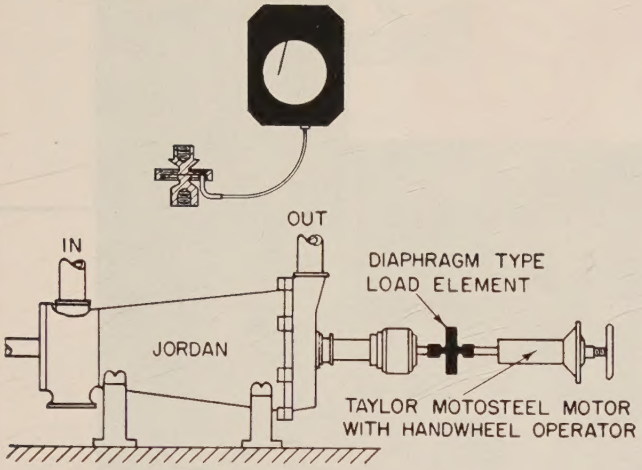
Solution: Taylor Ring Type Load Measuring Element with hole through center of element for loadscrew or shaft. Range limits 0-25,000 lbs. for compression loads only.

Results: more efficient beating—product quality raised to a new uniformly high level, production increased, time and power saved, conversion costs substantially reduced.



Taylor Volumetric Compression Load Element installed between the top lever and top roll bearing of a supercalender.

problems without friction...

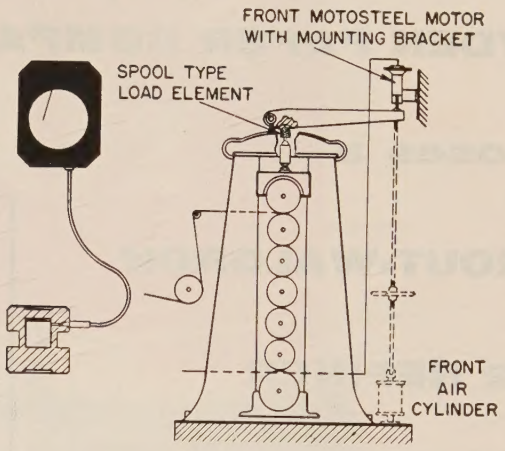


Diaphragm Type Load Measuring Element

Problem: to accurately measure processing pressure between the shell and plug knives in a Jordan.

Solution: Taylor Diaphragm Type Load Measuring Element. For tension or compression ranges from 0 to 6,250 lbs. Also commonly used for paper machine press rolls.

Results: uniformity of processing, despite variations in stock feed. Same settings give same results day after day.



Spool Type Load Measuring Element

Problem: to ensure uniform finish on paper in a supercalender.

Solution: Taylor Spool Type Load Measuring Elements —used at each end of the top roll. Range limits 0 to 400,000 lbs.

Results: proper nip pressure maintained across entire face of roll.

THE ANSWER is to use Taylor Volumetric Load Measuring Elements to measure tension or compression loads. You'll be assured of high accuracy of measurement because these instruments directly measure load *at point of application independent of friction from within loading system.*

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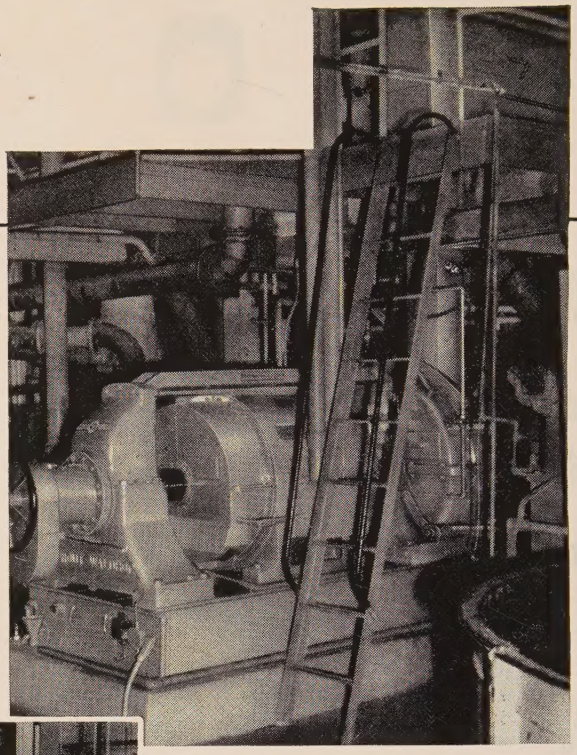

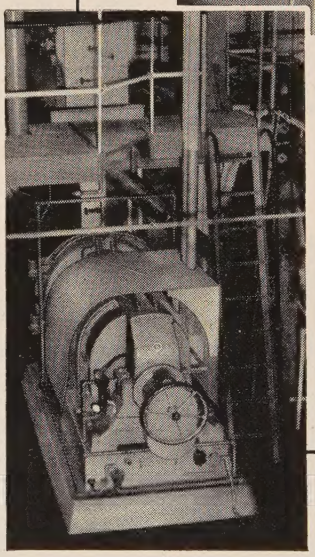

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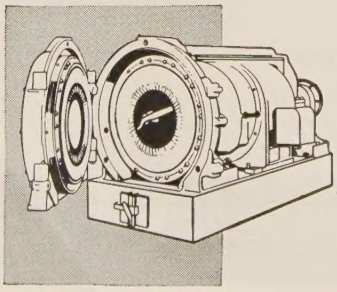

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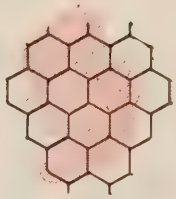

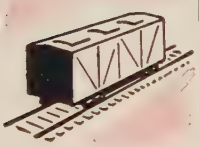

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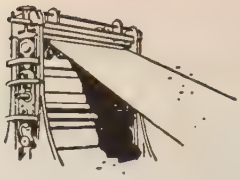

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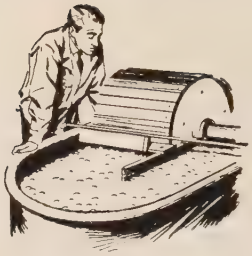

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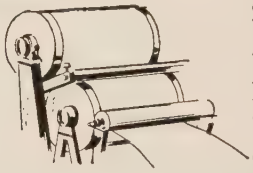

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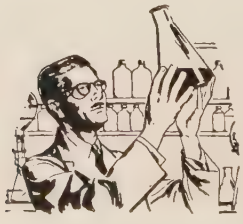

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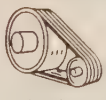
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RAW MATERIALS FOR MORE PAPER—II

FINDINGS OF AN FAO PULP AND PAPER CONSULTATION, ROME, ITALY, DECEMBER, 1952

The following is the continuation of the report, the first installment of which was published in the August issue of *Tappi*, covering the FAO pulp and paper consultation held in Rome, Italy, December, 1952. As previously indicated the original from which this is reprinted (FAO Forestry and Forest Products Study No. 6) contained an outline of pulping procedures and tests. This section will not be included in *Tappi* so those interested should refer to the complete report.

V. PROCESS COST ESTIMATES FOR PULPING FIBROUS RAW MATERIALS[28]

To estimate the value of any raw material for pulping it is necessary to know the processes which are suitable and the products in which the resulting pulps may be used. These aspects have been dealt with earlier. After the technical feasibility of pulping a given raw material has been determined, however, there still remains the problem of establishing whether operation would prove economic. Only careful investigation and analysis of each individual case can provide the answer.

Nevertheless, as a basis for general comparison it is necessary to use cost factors for conventional cases, based on conditions as they are found for modern operation in the main pulp-producing countries or regions. The cost data sheets which follow therefore should be interpreted with due caution. The examples quoted are hypothetical. They represent abstractions, based on assumptions which, at the moment, do not apply in any given place:

1. Wood and other fibrous materials have been taken at prices which are representative in certain areas where they are available. It must be emphasized, however, particularly in the case of tropical broadleaved woods, bagasse, and straw, that these may be obtainable at low prices in a number of countries because of the existing low level of industrialism in those countries and the fact that there is at present—both locally and elsewhere—little or no demand for these particular materials.

2. Chemicals, power, and steam have been taken at prices similar to those experienced by integrated mills in such industrially advanced countries as the United States. In underdeveloped countries they are substantially higher and in this respect the cost sheets will always require upward adjustment. The importance of chemical cost—of special implication in the case of processes without chemical recovery—varies with the process.

3. In processing fibrous raw materials the full benefit of large-scale operations and high technical skill, such as have been developed over many years of industrial experience, yield very considerable economies in lowering cost.

Even under the conditions given above in (3) costs differ between regions and between mills, according to the quality of the pulp and quality of equipment, as well as upon the degree of managerial efficiency. Working capacity also has its effect. The production costs, for instance, of bleached sulphate pulp in the southern regions of the United States, are less than in others, mainly on account of lower stumpage rates and also because of differences in the quality of pulps produced. Furthermore, investment costs per ton of pulp, and production costs, go down with increasing capacity till a certain limit is reached, the more complicated the installation the higher, usually, being the limit. On the other hand, the delivered cost of raw materials may often rise as requirements increase.

Another important variable is labor cost, based, on the one hand, on an average hourly rate, and on the other on human productivity—two factors which to a large extent are in inverse relationship to one another. The data sheets deliberately reduce the charges for labor and services to a common denominator in each case in order to facilitate comparison. Chemicals have been priced at approximate United States 1952 figures, except in the case of quicklime, limestone, and salt where conventional values—which might also be experienced in an underdeveloped country—have been used. Cost of electricity and steam has been assumed on the basis of an integrated power and steam development, as would be required in a substantial pulp and paper mill undertaking. Water is shown at an approximate price intended to cover the cost of pumping and treatment.

Table X. Unit Prices[a] for Estimation Purposes (in U. S. $)

Coniferous pulpwoods	25.00 per cord (9.80 per m.^{3})
Temperate broadleaved woods	19.00 per cord (7.50 per m.^{3})
Tropical broadleaved woods	10.00 per cord (4.00 per m.^{3})
Straw (90% dry)	15.00 per met. ton
Bagasse (depithed and 90% dry)	10.00 per met. ton
Bamboo (as in India and 90% dry)	24.00 per met. ton
Chemicals[b]	
Caustic soda	0.077 per kg.
Chlorine	0.084 per kg.
Quicklime (CaO)	0.015 per kg.
Hydrated lime	0.015 per kg.
Limestone	0.004 per kg.
Salt	0.010 per kg.
Salt cake	0.030 per kg.
Soda ash	0.030 per kg.
Sodium silicate	0.030 per kg.
Sulphur	0.030 per kg.
Services	
Electricity	0.008 per kw.-hr.
Steam	1.65 per met. ton
Water	0.05 per 1000 gal. (0.013 per m.^{3})
Labor	
Operating (including direct plant supervision)	1.70 per man-hour
Repair and maintenance	2.50 per man-hour

[a] Prices for coniferous pulpwoods, temperate broadleaved woods, and tropical broadleaved woods are based on wood delivered at mill, barked and chipped for digesters, or delivered to grinders; prices for straw, bagasse, and bamboo are based on material cut, delivered, cleaned, and dusted ready for digesters.

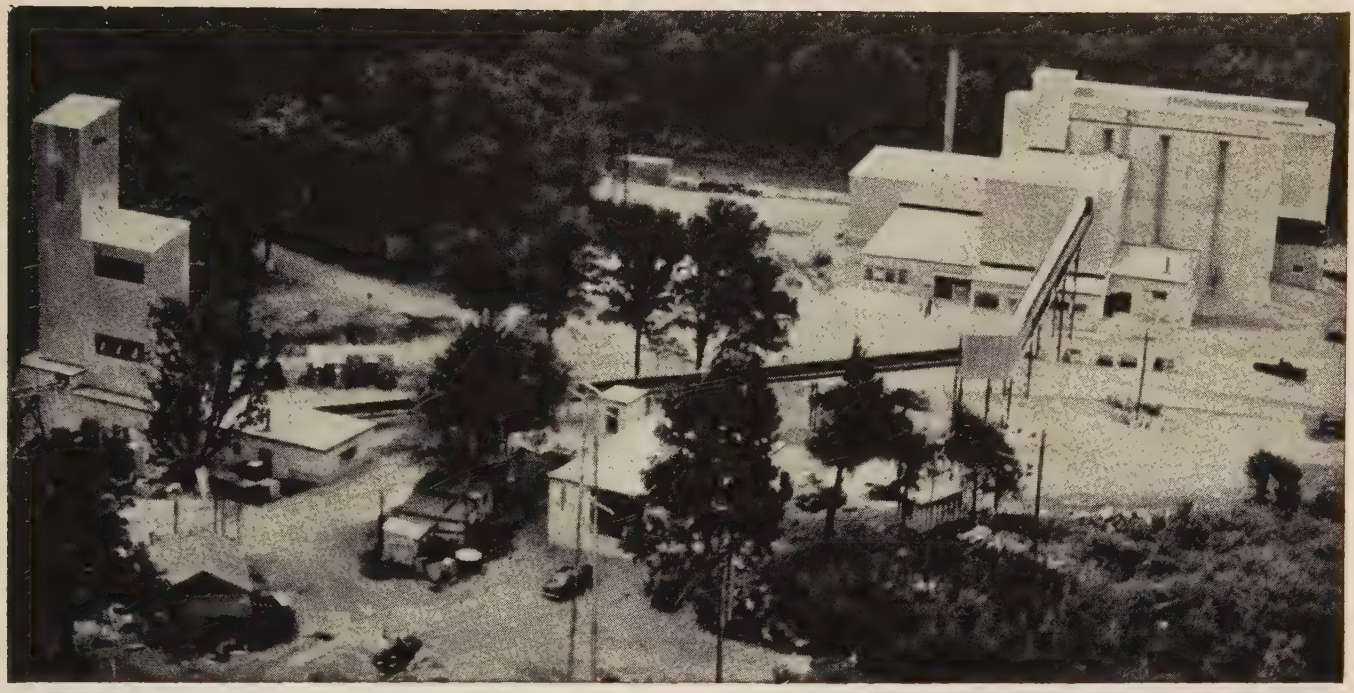
[b] Approximate 1952 U. S. prices—f.o.b. U. S. ports.

While all the calculations given have been limited to the production of slush pulp[29]—in order to illustrate the first stage of processing—integration of pulp manufacture with paper influences the economic balance favorably by eliminat-

[28] No consideration has been given to by-products such as alcohol in the case of the sulphite process or tall oil or turpentine in the case of the sulphate process.

[29] Additions of from $8 to $15 per short ton are suggested as reasonable allowances for sheeting and drying to 10 to 15% moisture content.

ANOTHER VANDERBILT PRODUCT



Gouverneur Talc Co., Gouverneur N. Y.

NYTAL

New York State Talc
for the Paper Industry
—Uniform Quality—

R. T. VANDERBILT CO. INC.
230 Park Avenue, New York 17, N. Y.

Cost Data Sheet 1. Raw Material: Coniferous Wood; Process: (a) Groundwood

(Production cost in U. S. $ per metric ton of slush pulp)

	Newsprint grade (pulp yield 95%)				*Steamed groundwood—board grade (pulp yield 85%)*			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*	*Quantity*	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Wood, clean barked, m.³	3.0	9.80	29.40	29.40	3.5	9.80	34.30	34.30
Miscellaneous materials	..	..	..	0.50	..	..	..	0.50
Operating expenses:								
Power, kw.-hr.	1100	0.008	8.80		600	0.008	4.80	
Water, m.³	40	0.013	0.52		150	0.013	1.95	
Labor, man-hours:								
Operating	2.2	1.70	3.74		5.0	1.70	8.50	
Repair	0.3	2.50	0.75		0.3	2.50	0.75	
Repair and maintenance materials	..	..	3.00		..	..	3.50	
Factory supervision and overheads	..	..	1.50		..	2.50		
Depreciation on plant and equipment	..	..	5.50	23.81	..	..	6.60	28.60
Estimated production cost of slush pulp				53.71				63.40

Notes: (1) Representative U. S. price for timber. (2) Estimates based on 50-ton daily capacity plant. (3) Estimated investment in plant and equipment (excluding steam and power): 1.2 to 1.5 million U. S. $. (4) Estimated working capital required: 0.6 to 1.0 million U. S. $.

Cost Data Sheet 2. Raw Material: Coniferous Wood; Process: (b) Sulphate

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached (pulp yield 48%)				*Bleached (pulp yield 43%)*			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*	*Quantity*	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Wood, cleaned and chipped, m.³	4.5	9.80	44.10	44.10	5.25	9.80	51.45	51.45
Chemicals, kg.:								
Sodium hydroxide	..	..	..		30	0.077	2.31	
Salt cake	90	0.03	2.70		100	0.03	3.00	
Limestone	30	0.004	0.12		33	0.004	0.13	
Hydrated lime	..	..	..		30	0.015	0.45	
Chlorine	..	..	..		80	0.084	6.72	
Miscellaneous	..	..	1.50	4.32	..	..	2.00	14.61
Operating expenses:								
Power, kw.-hr.	400	0.008	3.20		500	0.008	4.00	
Steam, m. tons								
Consumed	4.5	..	..		6.0	..	..	
Produced in alkali recovery	4.3	..	..		4.3	..	..	
Net consumption	0.2	1.65	0.33		1.7	1.65	2.80	
Water, m.³	100	0.013	1.30		250	0.013	3.25	
Labor, man-hours:								
Operating	5	1.70	8.50		6	1.70	10.20	
Repair	1	2.50	2.50		1.5	2.50	3.75	
Repair and maintenance materials	..	..	3.00		..	..	4.00	
Factory supervision and overheads	..	..	4.00		..	..	5.00	
Depreciation on plant and equipment	..	..	11.50		..	..	13.00	
				34.33				46.00
Estimated production cost of slush pulp				82.75				112.06

Notes: (1) Representative U. S. price for timber. (2) Estimates based on 100-ton daily capacity plant using full sulphate process including alkali recovery and lime reburning. (3) Estimated investment in plant and equipment: 4.5 to 6.0 million U. S. $ (excluding steam and power). (4) Estimated working capital required: 1.5 to 3.0 million U. S. $.

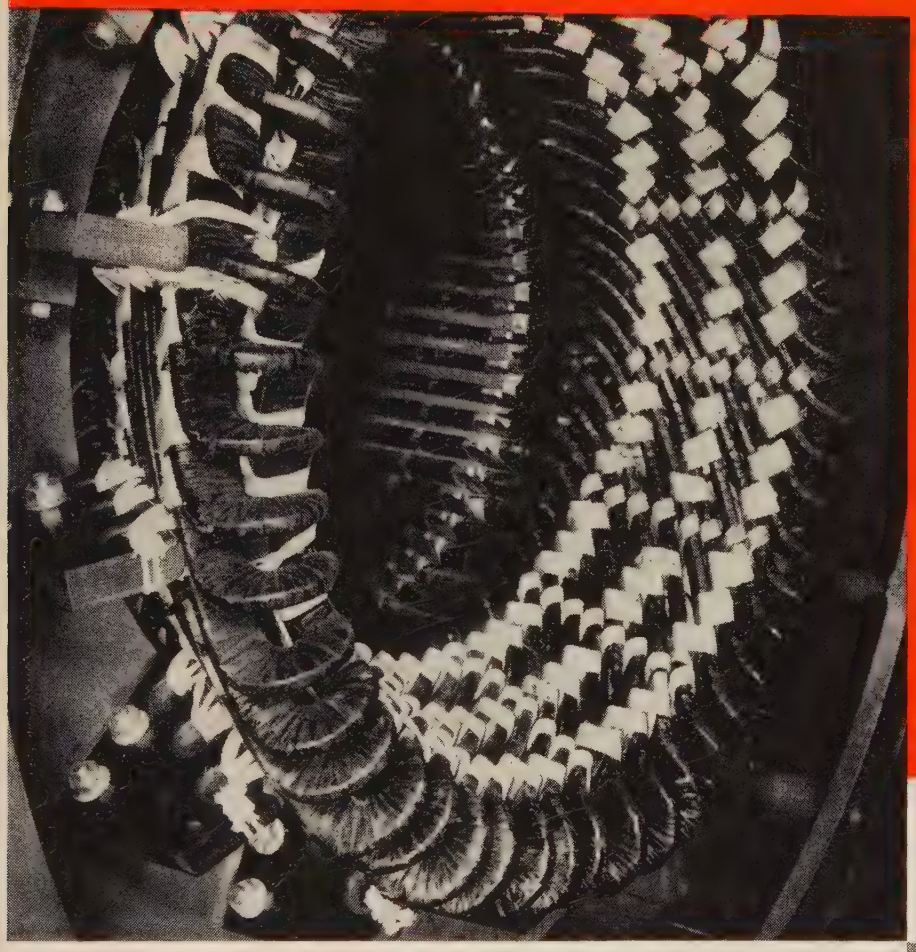
Cost Data Sheet 3. Raw Material: Coniferous Wood; Process: (c) Sulphite

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached (pulp yield 46%)				*Bleached (pulp yield 42%)*			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*	*Quantity*	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Wood, cleaned and chipped, m.³	5.0	9.80	49.00	49.00	5.4	9.80	52.92	52.92
Chemicals, kg.:								
Sodium hydroxide	..	..	..		10	0.077	0.77	
Limestone	150	0.004	0.60		165	0.004	0.66	
Hydrated lime	..	..	..		40	0.015	0.60	
Sulphur	120	0.030	3.60		130	0.030	3.90	
Chlorine	..	..	..		60	0.084	5.04	
Miscellaneous	..	..	1.50	5.70	..	..	2.00	12.97
Operating expenses:								
Power, kw.-hr.	300	0.008	2.40		370	0.008	2.96	
Steam, m. tons	3.0	1.65	4.95		3.5	1.65	5.78	
Water, m.³	200	0.013	2.60		400	0.013	5.20	
Labor man-hours:								
Operating	5	1.70	8.50		5.75	1.70	9.78	
Repair	1	2.50	2.50		1.5	2.50	3.75	
Repair and maintenance materials	..	..	3.00		..	..	4.00	
Factory supervision and overheads	..	..	4.00		..	..	5.00	
Depreciation on plant and equipment	..	..	11.50	39.45	..	..	13.00	49.47
Estimated production cost of slush pulp				94.15				115.36

Notes: (1) Representative U. S. price for timber. (2) Estimates based on 100-ton daily capacity plant, but excluding alcohol production and waste liquor burning. (3) Estimated investment in plant and equipment (excluding steam and power): 5.0 to 6.0 million U. S. $. (4) Estimated working capital required: 2.0 to 3.0 million U. S. $.

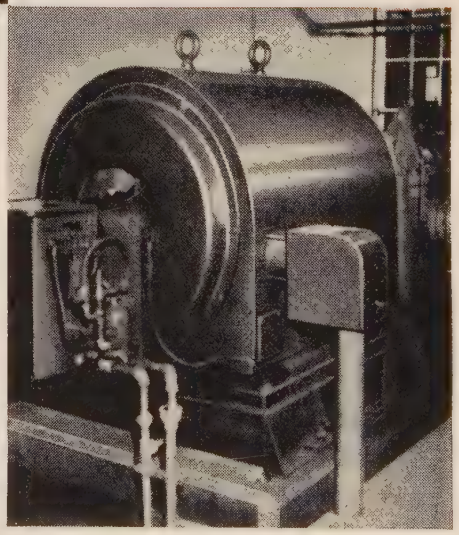
ELLIOTT CONSTRUCTION PRINCIPLES



mean longer life for motors on frequent starting service

You're looking inside a big Elliott two-pole induction motor—typical of those serving the industry on hydraulic barking pump drives and other tough installations. Note the extensive lashing used to restrain the movements of the stator coil end turns during starting. Fiberglas tape holds canvas phenolic blocks between adjacent coils in parallel rows which prevents coils within each phase group from pulling together during starting. This blocking also achieves an arch binding effect to restrict the coil phase groups from separating under starting stresses. The upper and lower portion of the coil end turns are lashed with Fiberglas cord to canvas phenolic blocks that are bolted to the frame to prevent any movement during starting.

Construction standards like this keep Elliott motor performance high. Ask your local Elliott representative for bulletins on the motor you need or write Elliott Company, Ridgway Division, Ridgway, Pa.



Elliott 900-hp two pole motor driving high-pressure centrifugal pump discharging at over 1300 psi, in a new pulp mill in the Northwest. Service requires an average of four starts per eight-hour shift.

Elliott FABRI-STEEL

ELLIOTT Company

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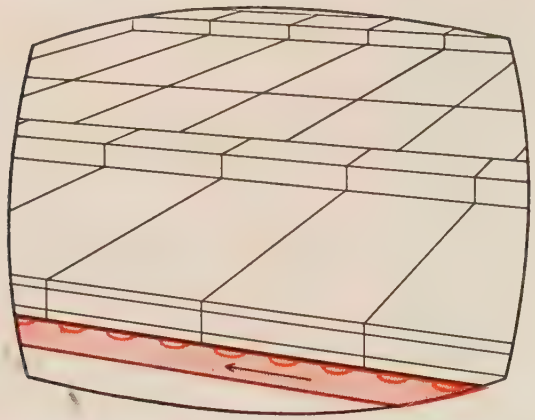
R3-16

A NEW PROVED WAY
TO BOOST
ON-MACHINE COATING CAPACITY

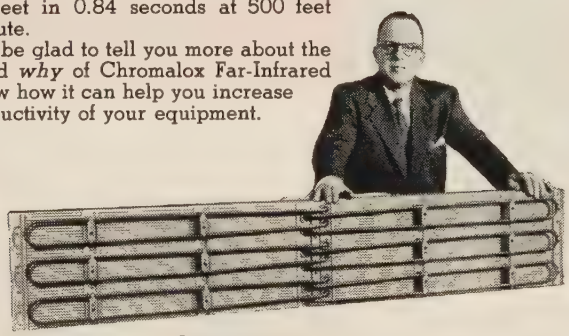


CHROMALOX Far-Infrared PANELS

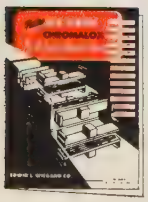
Speed up on-machine coating capacity and avoid rewinding! Chromalox Electric Far-Infrared Radiant Panels heat-set coating *without contact* and eliminate picking.

One mill is setting coatings on 200-inch paper, on machine, at 600 feet per minute with an exposure time of two seconds. Another mill is setting coating on 30-lb. basis sheet in 0.84 seconds at 500 feet per minute.

We'll be glad to tell you more about the *how* and *why* of Chromalox Far-Infrared and show how it can help you increase the productivity of your equipment.



CHROMALOX Far-Infrared Panels are heat powered with shockproof, splashproof metal-sheathed tubular elements. Panels up to 24" x 66" can be grouped to radiate high intensities uniformly over the widest webs. Output is variable from 4 to 100%. Mechanically and electrically complete, ready to install on circuits up to 600 V.



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Cost Data Sheet 4. Raw Material: Temperate Broadleaved Woods; Process: (a) Cold Caustic (Refined Pulp)

(Production cost in U. S. $ per metric ton of slush pulp)

	Groundwood type—semibleached (pulp yield 88%)			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Wood, cleaned and chipped, m.³	2.3	7.50	17.25	17.25
Chemicals, kg.:				
Sodium hydroxide	100	0.077	7.70	
Hydrated lime	100	0.015	1.50	
Chlorine	90	0.084	7.56	
Sodium silicate	20	0.030	0.60	
Miscellaneous	..	..	1.50	18.86
Operating expenses:				
Power, kw.-hr.	600	0.008	4.80	
Water, m.³	80	0.013	1.04	
Labor, man-hours:				
Operating	4	1.70	6.80	
Repair	1	2.50	2.50	
Repair and maintenance materials	..	..	2.00	
Factory supervision and overheads	..	..	2.00	
Depreciation on plant and equipment	..	..	7.00	26.14
Estimated production cost of semibleached slush pulp				62.25

Notes: (1) Representative U. S. price for timber. (2) Estimates based on 50-ton daily capacity plant, without chemical recovery. (3) Estimated investment in plant and equipment (excluding steam and power): 1.2 to 1.5 million U. S. $. (4) Estimated working capital required: 0.5 to 0.8 million U. S. $.

ing intermediate drying and transportation costs, and reducing service and overhead charges.

If calculated local costs are found to be in line with the estimates, then plant operations may be justified economically, provided quality of the products is acceptable and transportation costs to consumers are not excessive. Local production may even be worth while where it is possible to show that general economic factors such as heavy import duties, import restrictions, and shortage of hard currency compensate for relatively high cost of manufacture, but evaluation of such circumstances goes beyond the scope of the present publication. On the other hand, a satisfactory position on the inland market is no proof of the ability to compete in foreign markets where product quality is of supreme importance and where additional disadvantages (freight, insurance, duty, commission) and insufficient knowledge of market conditions have to be overcome. All these matters must be most carefully examined and assessed before any new project is planned.

VI. CASE HISTORIES

In view of the amount of detailed information contained in the preceding chapters it was considered that some summarization in the case of certain raw material groups would be both helpful and expedient. These summaries, of which there are four, have been termed "case histories," and they cover: tropical broadleaved woods, straw, sugarcane bagasse, and bamboo.

Tropical Broadleaved Woods[30,31]

Raw Material

Supply. Of the four billion hectares, which represent the total forest area of the world, tropical forests occupy about 45%. There are approximately 800 million hectares in Africa and 600 million in South America, but of the timber

[30] Except for important isolated stands of coniferous woods in southern Brazil, Central America, the Caribbean, and the Far East, all naturally occurring species in the tropics and the southern hemisphere are broadleaved. Exotic conifers are available in a number of southern hemisphere localities. Australia, New Zealand, and South Africa being important cases in point.

[31] For cost data sheet see Chapter V.

How to judge SUCTION BOX COVERS

Emerson End-of-Grain SUCTION BOX COVERS

Check on these 9 features —

- ✔ **Permanent Frames**
- ✔ **No lost suction**
- ✔ **Greater suction surface**
- ✔ **Long, trouble-free wear**
- ✔ **Wire life protection**
- ✔ **No streaking**
- ✔ **Ease of installation**
- ✔ **Economical replacement**
- ✔ **Easy maintenance**

***You get these features and more in* Emerson End-of-Grain Suction Box Covers.**

Emerson Suction Box Covers come framed in corrosion-resistant brass or stainless steel rails channeled for insertion of wooden strips to form a complete seal on any standard suction box. The Emerson exclusive oblong slots cut on the diagonal provide maximum suction surface, even formation of the sheet without streaking, and freedom from clogging.

Constructed of Vermont Rock Maple with the grain running vertically, Emerson Suction Box Covers outwear the conventional plank covers from 3 to 10 times, depending on the speed of the machine and the grade of paper being made. With ¾" or more wearing surface on each cover, a minimum of dressing is required due to the stubborn resistance to wear of the woods mounted with the grain running up and down.

Wire life is protected by reducing friction of the wire on the glass-like surface of the covers and the absence of damaging grit or splinters. The design of Emerson Suction Box Covers helps to keep the wires flat, thereby reducing friction drag and power to operate.

Emerson Suction Box Covers are easy to install, easy and economical to replace. Once the complete cover is installed on the suction box, refill sections may be purchased at about half the original cost, slipped into place and locked in the installed rails by adjustable jack screws on each end.

The next time you need Suction Box Covers, consider Emerson—made for Wire or Felt. For tapered boxes. For wide boxes, multiple covers that will not sag or raise. For quick sheet formation, slotted type covers for maximum drainage. Other special applications.

The Emerson Manufacturing Co.

Division of John W. BOLTON & Sons, Inc.

Lawrence, Massachusetts, U. S. A.

Cost Data Sheet 5. Raw Material: Temperate Broadleaved Woods; Process: (b) Neutral Sulphite Semichemical

(Production cost in U. S. $ per metric ton of slush pulp)

	High yield for corrugating (pulp yield 75%)				*Bleached for printing paper (pulp yield 58%)*			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*	*Quantity*	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Wood, cleaned and chipped, m.³	2.73	7.50	20.47	20.47	3.45	7.50	25.87	25.87
Chemicals, kg.:								
Sodium hydroxide	..	..	..		21	0.077	1.62	
Soda ash (Na_2CO_3)	136	0.030	4.08		230	0.030	6.90	
Hydrated lime	..	..	..		40	0.015	0.60	
Sulphur	28	0.030	0.84		54	0.030	1.62	
Chlorine	..	..	..		136	0.084	11.42	
Miscellaneous	..	..	1.00	5.92	..	..	1.25	23.41
Operating expenses:								
Power, kw.-hr.	350	0.008	2.80		430	0.008	3.44	
Steam, m. tons	2	1.65	3.30		3.5	1.65	5.78	
Water, m.³	80	0.013	1.04		170	0.013	2.21	
Labor, man-hours:								
Operating	3	1.70	5.10		4	1.70	6.80	
Repair	0.5	2.50	1.25		1	2.50	2.50	
Repair and maintenance materials	..	..	2.00		..	..	3.00	
Factory supervision and overheads	..	..	2.50		..	..	3.00	
Depreciation on plant and equipment	..	..	7.00	24.99	..	..	9.00	35.73
Estimated production cost of slush pulp				51.38				85.01

Notes: (1) Representative U. S. price for timber. (2) Estimates based on 50-ton daily capacity plant, without chemical recovery. (3) Estimated investment in plant and equipment (excluding steam and power): 1.0 to 1.5 million U. S. $ for high yield plant; 1.5 to 2.0 million U. S. $ for bleached pulp plan. (4) Estimated working capital required: 0.5 to 0.8 million U. S. $.

from this very large area only small quantities may be utilized for pulping at the present time, mainly on account of economic factors.

General Characteristics of Tropical Forests. Apart from the mangrove area, it is impossible to give general characteristics for tropical forests because they vary so greatly. Usually the tropical forest is composed of a large number of mixed species, and the mixture includes some of the heaviest woods as well as some of the lightest. There are similar extremes in chemical composition and fiber characteristics. Some of the woods produce pulps equal or superior in quality to those from the better temperate broadleaved woods. Others, because of their high lignin content, high extractives, or thick-walled short fibers, produce pulps of poor quality. In some instances species which possess pulping characteristics similar to those of the better temperate broadleaved woods are available, and in sufficient quantity to permit their selection for pulping by conventional processes. The large majority of tropical forests, however, are characterized by wide heterogeneity, and it is necessary to utilize a whole mixture of species essentially as it occurs. It is this general aspect to which the most of this "case history" is devoted.

Determination of the stand composition of an area of 50,000 hectares—sufficient in some areas to supply a mill with a daily capacity of 200 tons—requires careful statistical analysis. It can only be done by accurate sampling of the total area involved and close examination of results against distribution curves. Factors which have to be considered include: (1) number of trees per hectare; (2) volume of wood per hectare; (3) weight of dry wood per hectare; (4) distribution of diameters; (5) distribution of species and probable composition of the forest by small areas; (6) determination of those factors which will give an indication of the characteristics of the pulp (i.e., average ratio diameter/lumen of the fibers, average content of lignin etc.).

It is recommended that the sampling be undertaken at

Cost Data Sheet 6. Raw Material: Tropical Broadleaved Woods; Process: Sulphate

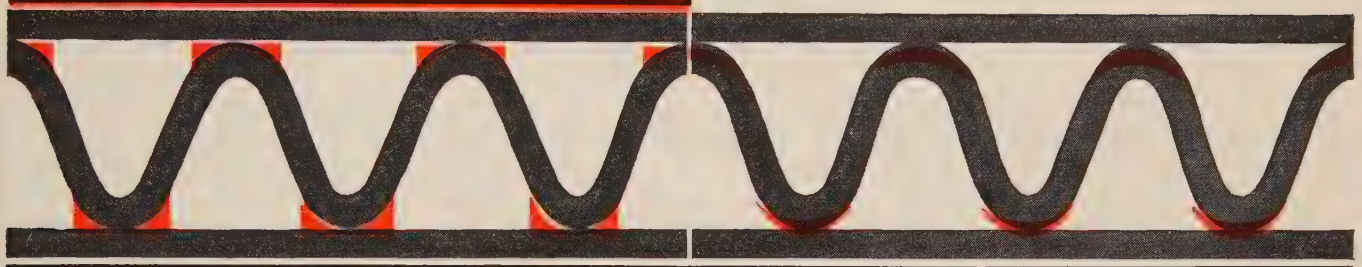
(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached (pulp yield 52%)				*Bleached (pulp yield 48%)*			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*	*Quantity*	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Wood, cleaned and chipped, m.³	3.0	4.00	12.00	12.00	3.3	4.00	13.20	13.20
Chemicals, kg.:								
Sodium hydroxide	..	..	..		30	0.077	2.31	
Salt cake	80	0.030	2.40		90	0.030	2.70	
Limestone	27	0.004	0.11		30	0.004	0.12	
Hydrated lime	..	..	..		20	0.015	0.30	
Chlorine	..	..	..		60	0.084	5.04	
Miscellaneous	..	..	1.50	4.01	..	..	2.00	12.47
Operating expenses:								
Power, kw.-hr.	325	0.008	2.60		425	0.008	3.40	
Steam, m. tons								
Consumed	4.3	..	..		5.8	..	..	
Produced in alkali recovery	4.3	..	..		4.3	..	..	
Net consumption	..	..	..		1.5	1.65	2.47	
Water, m.³	100	0.013	1.30		250	0.013	3.25	
Labor, man-hours:								
Operating	5	1.70	8.50		6	1.70	10.20	
Repair	1	2.50	2.50		1.5	2.50	3.75	
Repair and maintenance materials	..	..	3.00		..	..	4.00	
Factory supervision and overheads	..	..	4.00		..	..	5.00	
Depreciation on plant and equipment	..	..	11.50	33.40	..	..	13.00	45.07
Estimated production cost of slush pulp				49.41				70.74

Notes: (1) Representative *local price for timber*, but with *conventional U. S. process* cost data. (2) Estimates based on 100-ton daily capacity plant using full sulphate process including alkali recovery and line reburning, but omitting electrolysis. (3) Estimated investment in plant and machinery (excluding steam and power): 4.5 to 6.0 million U. S. $. (4) Estimated working capital required: 1.0 to 3.0 million U. S. $.

GEL POINT control insures good adhesive

BOND



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This graphic illustration shows how bond is improved if penetration is controlled with the inclusion of a fraction of a percent of Kelsize in the starch adhesive formula. Retention of water and water soluble chemicals in correct proportion with raw starch at the glue line is essential for proper gelatinization of the raw starch mixture.

POOR BOND

The above illustration shows how the moisture of the adhesive tends to migrate into the medium, leaving an unbalanced starch mixture at the glue line. Poor bond will result if the moisture of the starch paste soaks into the liners and medium before heat is applied and gel point reached.

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Cost Data Sheet 7. Raw Material: Straw; Process: (a) Lime

(Production cost in U. S. $ per metric ton of slush pulp)

	Board grade (pulp yield 75%)			
	Quantity	Unit cost, $	Cost per ton, $	Total, $
Straw, cleaned and dusted, m. tons	1.35	15.00	20.25	20.25
Chemicals, kg.:				
Hydrated lime	115	0.015	1.73	
Miscellaneous	..	..	1.00	2.73
Operating expenses:				
Power, kw.-hr.	120	0.008	0.96	
Steam, m. tons	0.9	1.65	1.50	
Water, m.^{3}	25	0.013	0.33	
Labor, man-hours:				
Operating	6.0	1.70	10.20	
Repair	0.5	2.50	1.25	
Repair and maintenance materials	..	..	1.50	
Factory supervision and overheads	..	..	4.00	
Depreciation on plant and equipment	..	..	7.00	26.74
Estimated production cost of slush pulp				49.72

Notes: (1) Estimates based on 20 ton daily capacity plant. (2) Estimated investment in plant and equipment (excluding steam and power): 0.5 to 0.8 million U. S. $. (3) Estimated working capital required: 0.2 to 0.3 million U. S. $.

random and a sample of 1% over small areas of 1 hectare may be regarded as sufficient for a preliminary study.

The table below shows (with a maximum error of 25%) the average results of a recent inventory of 1% on a forest in French Africa:

	Number of trees in 1 ha.	Volume in m.^{3}	Weight of dry wood, met. tons
Diameter between 15 and 60 cm. (6–24 in.)	330	150	105
Diameter exceeding 60 cm. (24 in.)	20	100	70
Total	350	250	175
Number of different species in 1 ha.	about 100		
Number of different species in the whole area (50,000 ha.)	about 250		

The above table, although obviously not typical of all tropical forests, indicates the necessity of cooking a mixture of species in most cases.

An important exception to the general run of tropical forests is the genus Cecropia of the *Moraceae* (mulberry family) which is abundant in many parts of tropical America. This genus is variously called "cetico" in Peru; "guaruma" in Ecuador, Columbia, and Central America; and "yagrumo" in Puerto Rico and Cuba. It is found principally in the rain forest area, at low to medium elevations, and needs full sunlight for best development. Cecropia seeds very abundantly on abandoned clearings and on newly made land along rivers. Its relative abundance increases when forests are cut over. It sprouts from the stumps very freely, and is among the fastest growing trees in the world. The wood which is devoid of gum and other extractives is grayish white, and has a specific gravity of from 0.24 to 0.32 (15 to 20 lb. per cubic foot air dry).

Because of its abundance and frequent occurrence in pure stands Cecropia should be an important factor in any pulp and paper development in tropical America, especially in Peru, Ecuador, and Columbia.

Exploitation. Two favorable factors characterize the tropical forest as a source of pulpwood. The number of trees per hectare (and the volume and density of timber) may be high and reproduction and regrowth rapid, provided good principles of management are used and maintained. In many cases these principles are not known, and trained foresters will be required in order to obtain satisfactory results.

The cost of wood delivered at the mill is comparatively low. A value of $2.00 to $6.00 per cubic meter of green wood has been indicated.

Certain difficulties may be foreseen, however, such as the rainy season and decay of the wood—particularly of light woods in a tropical climate.

General Characteristics of Tropical Broadleaved Woods. The composition of tropical broadleaved woods varies considerably within individual species.

Density: The density of the wood varies from 0.2 to 1.2. The average is about 0.6 to 0.7.

Chemical composition: Owing to wide variation in chemical composition, the only conclusions that may be drawn for tropical woods in French Africa are the following: the content of cellulose is about 45% (Kürschner cellulose), that of lignin is generally high (averaging 32%, but sometimes exceeding 40%), while the content of pentosans is generally about 15%, but sometimes more than 20%. Certain woods

Cost Data Sheet 8. Raw Material: Straw; Process: (b) Soda

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached—board grade (pulp yield 60%)				Bleached (pulp yield 40%)			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Straw, cleaned and dusted, m. tons	1.7	15.00	25.50	25.50	2.5	15.00	37.50	37.50
Chemicals, kg.:								
Sodium hydroxide	100	0.077	7.70		300	0.077	23.10	
Hydrated lime	..	..	..		40	0.015	0.60	
Chlorine	..	..	..		100	0.084	8.40	
Miscellaneous	..	..	1.00	8.70	..	..	1.50	33.60
Operating expenses:								
Power, kw.-hr.	200	0.008	1.60		380	0.008	3.04	
Steam, m. tons	1.1	1.65	1.82		3.0	1.65	4.95	
Water, m.^{3}	75	0.013	0.98		200	0.013	2.60	
Labor, man hours:								
Operating	7.0	1.70	11.90		8	1.70	13.60	
Repair	0.5	2.50	1.25		1	2.50	2.50	
Repair and maintenance materials	..	..	2.00		..	..	3.00	
Factory supervision and overheads	..	..	5.00		..	..	5.00	
Depreciation on plant and equipment	..	..	9.00	33.55	..	..	12.00	46.69
Estimated production cost of slush pulp				67.75				117.79

Notes: (1) Estimates based on 20-ton daily capacity plant without alkali recovery; with alkali recovery costs would be similar to full sulphate process. (2) Estimated investment in plant and equipment (excluding steam and power): 0.7 to 1.3 million U. S. $. (3) Estimated working capital required: 0.3 to 0.5 million U. S. $.

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Cost Data Sheet 9. Raw Material: Straw; Process: (c) Sulphate

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached—board grade (pulp yield 60%)				Bleached (pulp yield 45%)			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Straw, cleaned and dusted, m. tons	1.7	15.00	25.50	25.50	2.2	15.00	33.00	33.00
Chemicals, kg.:								
Sodium hydroxide	..	..	..		20	0.077	1.54	
Salt cake	40	0.030	1.20		125	0.030	3.75	
Quicklime (CaO)	80	0.015	1.20		200	0.015	3.00	
Chlorine	..	..	..		60	0.084	5.04	
Miscellaneous	..	..	1.50	3.90	..	..	2.00	15.33
Operating expenses:								
Power, kw.-hr.	400	0.008	3.20		500	0.008	4.00	
Steam, m. tons								
Consumed	4.5	..	..		6.0	..	..	
Produced by recovery	3.0	..	..		4.3	..	..	
Net consumption	1.5	1.65	2.48		1.7	1.65	2.80	
Water, m.^{3}	100	0.013	1.30		250	0.013	3.25	
Labor, man-hours:								
Operating	5	1.70	8.50		6	1.70	10.20	
Repair	1	2.50	2.50		1.5	2.50	3.75	
Repair and maintenance materials	..	..	3.00		..	..	4.00	
Factory supervision and overheads	..	..	4.00		..	..	5.00	
Depreciation on plant and equipment	..	..	12.00	36.98	..	..	14.00	47.00
Estimated production cost of slush pulp				66.38				95.33

Notes: (1) Estimates based on 50-ton daily capacity plant using full sulphate process, including alkali recovery but excluding lime burning. (2) Estimated investment in plant and equipment (excluding steam and power): 2.5 to 3.5 million U. S. $. (3) Estimated working capital required: 1.0 to 1.5 million U. S. $.

contain a high proportion of silica and some have high extractives.

Fibers: Dimensions of the true fibers differ according to the species. Length varies from 0.7 to 4 mm., but for most of the species the average length is between 1 and 2 mm. There are, however, some quite frequently occurring species ("Strombosia," for example) which have a very long fiber (3 to 4 mm.).

The ratio diameter/lumen is also very variable.

Processes

Chipping. Chipping difficulties depend on the density of the wood, and it is necessary to provide chippers with more power than that required for spruce.

Furthermore, the generally high percentage of silica increases the wear on knives. Specially hardened chipper knives, however, have been developed for use on broadleaved woods.

Pulping. It has been established that cooking of heterogeneous mixtures of species is possible and in some cases desirable from the standpoint of pulp quality. Therefore, with the exclusion of those species having higher value as lumber, if the average pulping characteristics of trees in a certain forest area are suitable, it is possible to produce a satisfactory pulp with the following provisos: (1) elimination of certain species particularly difficult to pulp; (2) establishment of carefully detailed forest statistics to allow harvesting in such a way that mixtures of woods arriving at the mill are as uniform in pulping characteristics as possible; (3) blending at all the stages of the mill operation (log piles, chippers, silos, etc.) in order to maintain a uniform distribution of wood types.

Different processes have been examined in a number of laboratories, especially in France, and two mills have studied this problem on an industrial scale. One of these is the pilot plant of RICC (Régie Industrielle Cellulose Coloniale) on the Ivory Coast, which is an integrated mill with a capacity of 6000 tons a year producing wrapping paper with the soda sulphur process. It is eventually intended to install electrolytic equipment and to bleach the pulp. The other mill is in Brazil, usually pulping Parañá pine but also using tropical hardwoods. Cecropia has been tested in laboratories in

Cost Data Sheet 10. Raw Material: Straw; Process: (d) Neutral Sulphite or Monosulphite

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached (pulp yield 62%)				Bleached (pulp yield 45%)			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Straw, cleaned and dusted, m. tons	1.60	15.00	24.00	24.00	2.20	15.00	33.00	33.00
Chemicals, kg.:								
Soda ash	130	0.030	3.90		260	0.030	7.80	
Hydrated lime	..	..	..		20	0.015	0.30	
Sulphur	30	0.030	0.90		60	0.030	1.80	
Chlorine	..	..	..		75	0.084	6.30	
Miscellaneous	..	..	1.00	5.80	..	..	1.50	17.70
Operating expenses:								
Power, kw.-hr.	200	0.008	1.60		380	0.008	3.04	
Steam, m. tons	1.5	1.65	2.48		3.0	1.65	4.95	
Water, m.^{3}	75	0.013	0.98		150	0.013	1.95	
Labor, man-hours:								
Operating	7	1.70	11.90		8	1.70	13.60	
Repair	0.5	2.50	1.25		1	2.50	2.50	
Repair and maintenance materials	..	..	2.00		..	..	3.00	
Factory supervision and overheads	..	..	5.00		..	..	5.00	
Depreciation on plant and equipment	..	..	9.00	34.21	..	..	12.00	46.04
Estimated production cost of slush pulp				64.01				96.74

Notes: (1) Estimates based on 20-ton daily capacity plant, without chemical recovery. (2) Estimated investment in plant and equipment (excluding steam and power): 0.7 to 1.3 million U. S. $. (3) Estimated working capital required: 0.3 to 0.5 million U. S. $.

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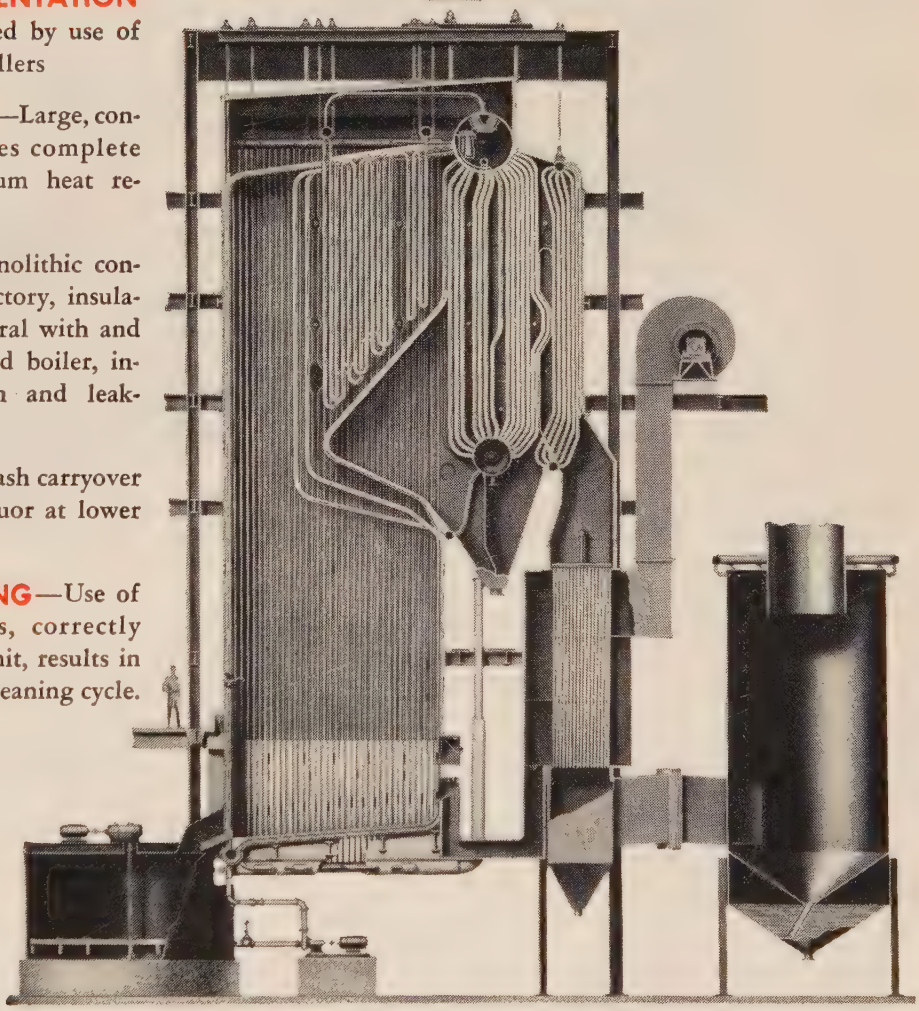

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Cost Data Sheet 11. Raw Material: Straw; Process: (e) Caustic Soda-Chlorine (Semipulp)

(Production cost in U. S. $ per metric ton of slush semipulp)

	Unbleached—board grade (pulp yield 65%)			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*
Straw, cleaned and dusted, m. tons	1.54	15.00	23.10	23.10
Chemicals, kg.:				
Sodium hydroxide	130	0.077	10.01	10.01
Miscellaneous	..	..	..	0.50
Operating expenses:				
Power, kw.-hr.	150	0.008	1.20	
Steam, m. tons	1.1	1.65	1.82	
Water, m.³	50	0.013	0.65	
Labor, man-hours:				
Operating	3	1.70	5.10	
Repair	0.5	2.50	1.25	
Repair and maintenance materials	..	..	1.50	
Factory supervision and overheads	..	..	5.00	
Depreciation on plant and equipment	..	..	5.00	21.52
Estimated production cost of slush semipulp				55.13

Notes: (1) Estimates based on 20-ton daily capacity plant, without chemical recovery. (2) Estimated investment in plant and equipment (excluding steam and power): 0.4 to 0.6 million U. S. $. (3) Estimated working capital required: 0.3 to 0.5 million U. S. $.

France, Italy, and the U.S.A. and was made into groundwood as well as chemical pulps for newsprint.

The results of these studies may be summarized as follows:

Groundwood: Numerous tropical broadleaved woods because of coloration and high density cannot be converted to a satisfactory groundwood pulp. This therefore precludes the use of mixtures. However, Cecropia which occurs in pure stands, makes a satisfactory groundwood.

Semichemical pulping: Cold caustic soda. Laboratory scale trials give very promising results with mixtures of tropical broadleaved woods. The pulps thus obtained may be bleached in certain cases with not more than 10% chlorine. Such pulps may be found suitable for newsprint manufacture.

Neutral sulphite. Laboratory trials so far have given only fair results with the conventional process. Better results have been obtained when the cooking liquor is buffered by the addition of caustic soda.

Sulphite process: Although some woods pulp well with this process, most tropical broadleaved woods give poor results. Pulp strength and yield are low, and many species digest only with difficulty. Further, the sulphite process is very unsatisfactory for cooking the heterogeneous mixtures of species so often encountered. The necessity for complete barking may cause difficulty.

Sulphate process: At present, the sulphate process seems to be particularly advisable for the treatment of a widely heterogeneous mixture in order to get suitable quality bleached or unbleached pulp.

Unbleached pulps can be obtained with a yield of about 46 to 52% under normal conditions of cooking with a sulphidity of 25 to 30%. The characteristics of the pulp are illustrated by the following data obtained from a commercial run in a tropical African pulp and paper mill at about 40° S.-R.:

Breaking length	6500 to 7500 m. (average of two directions)
Burst factor	35 to 45
Tear factor	100 to 130
Double folds	150 to 500

Bleached pulps of 80 to 82 brightness G.E. can be obtained from the unbleached grade by conventional multistage bleaching—possibly using as a last stage, chlorine dioxide or sodium peroxide. The characteristics of the bleached pulps on the basis of hand sheets, beaten to 35° S.-R., are:

Breaking length	8000 to 9000
Burst factor	50 to 60
Tear factor	100 to 120
Double folds	200 to 500

Applications and Requirements

It must be emphasized that application of pulping processes to tropical woods will almost invariably take place in underdeveloped countries where chemicals and usually electric power are scarce and expensive.

Furthermore, lack of facilities indicates the use of only well-known processes, with such modifications as may be required for the mixed woods used, and also the greatest possible reduction of chemical losses.

One solution to this problem which is applicable for bleached pulp is to make chemicals by electrolysis of salt in conjunction with conventional alkali recovery. In this case caustic produced would be used together with sulphur, as make-up for

Cost Data Sheet 12. Raw Material: Straw; Process: (f) Caustic Soda-Chlorine (Full Bleached Pulp)

(Production cost in U. S. $ per metric ton of slush pulp)

	Bleached (purchased chemicals) (pulp yield 43%)				*Bleached (electrolytic plant) (pulp yield 43%)*			
	Quantity	*Unit cost, $*	*Cost per ton, $*	*Total, $*	*Quantity*	*Unit Cost $*	*Cost per ton, $*	*Total, $*
Straw, cleaned and dusted, m. tons	2.3	15.00	34.50	34.50	2.3	15.00	34.50	34.50
Chemicals, kg.:								
Sodium hydroxide	275	0.077	21.18		..	..	..	
Hydrated lime	20	0.015	0.30		20	0.015	0.30	
Chlorine	230	0.084	19.32		..	..	..	
Salt	..	..	..		500	0.010	5.00	
Miscellaneous	..	..	1.50	42.30	..	..	2.50	7.80
Operating expenses:								
Power, kw.-hr.	440	0.008	3.52		1200	0.008	9.60	
Steam, m. tons	2.3	1.65	3.80		3.0	1.65	4.95	
Water, m.³	440	0.013	5.72		440	0.013	5.72	
Labor, man-hours:								
Operating	6	1.70	10.20		9	1.70	15.30	
Repair	2	2.50	5.00		2.5	2.50	6.25	
Repair and maintenance materials	..	..	4.00		..	..	6.00	
Factory supervision and overheads	..	..	5.00		..	..	6.00	
Depreciation on plant and equipment	..	..	14.00	51.24	..	..	18.00	71.82
Estimated production cost of bleached slush pulp				128.04				114.12

Notes: (1) Estimates based on 20-ton capacity plant, without chemical recovery. (2) Estimated investment in plant and equipment (excluding steam and power). without electrolytic plant 1.2 to 1.7 million U. S. $; with electrolytic plant (diaphragm-type cells) 1.5 to 2.0 million U. S. $. (3) Estimated working capital required: 0.3 to 0.5 million U. S. $.

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Cost Data Sheet 13. Raw Material: Straw; Process: (g) Mechano-Chemical

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached—board grade (pulp yield 65%)				Bleached (pulp yield 48%)			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Straw, cleaned and dusted, m. tons	1.6	15.00	24.00	24.00	2.1	15.00	31.50	31.50
Chemicals, kg.:								
Caustic soda	95	0.077	7.31		190	0.077	14.63	
Chlorine	..	..	..		125	0.084	10.50	
Hydrated lime	..	..	..		40	0.015	0.60	
Miscellaneous	..	..	1.00	8.31	..	..	1.50	27.23
Operating expenses:								
Power, kw.-hr.	300	0.008	2.40		500	0.008	4.00	
Steam, m. tons	3.0	1.65	4.95		4.0	1.65	6.60	
Water, m.³	100	0.013	1.30		200	0.013	2.60	
Labor, man-hours:								
Operating	5	1.70	8.50		6	1.70	10.20	
Repair	0.5	2.50	1.25		1.0	2.50	2.50	
Repair and maintenance materials	..	..	1.50		..	..	2.50	
Factory supervision and overheads	..	..	5.00		..	..	5.00	
Depreciation on plant and equipment	..	..	9.00	33.90	..	..	12.00	45.40
Estimated production cost of slush pulp				66.21				104.13

Notes: (1) Estimates based on 20-ton daily capacity plant, without chemical recovery; with chemical recovery, costs would be similar to full sulphate process. (2) Estimated investment in plant and equipment (excluding steam and power): 0.7 to 1.3 million U. S. $. (3) Estimated working capital required: 0.3 to 0.5 million U. S. $.

chemical losses instead of salt cake. It is possible to use the chemicals in the proportion produced by electrolysis.

The following approximate requirements are needed to manufacture one metric ton of bleached pulp:

Green wood	3500–4000 kg. (according to moisture content)
Salt (sodium chloride)	220 kg. (485 lb.)
Sulphur	30 kg. (65 lb.)
Lime	80 kg. (175 lb.)
Power	1000–1100 kw.-hr.
Fuel oil	300 kg. (100 gal.) for steam complement (in addition to black liquor burning). Could be substituted by 1.15 metric tons green wood.
Water	200–400 m.³ (50,000–100,000 gal.)
Investment (including electrolysis, but not chlorine dioxide production, and some housing facilities)	approximately $120,000/daily ton

Products

When mixtures of wood are favorable, bleached sulphate pulp from tropical broadleaved woods is of a very high quality, and may be used for such grades as writing and printing paper. Semibleached pulps may be used for specialty wrapping papers and as a substitute for unbleached sulphite in newsprint etc.

Table XI. Possible Uses of Tropical Broadleaved Wood Sulphate Pulp

Pulp quality	Type of paper	Suggested percentage
Unbleached	Kraftliner	50
	Wrapping, 3rd strength	40–100
	Wrapping, 2nd strength	100
	Wrapping, 1st strength	70
Semibleached	Newsprint	20
	Magazine	50–100
	Wrapping, 2nd strength	100
Bleached	Magazine	50–100
	Fine paper, 2nd quality	60–100
	Fine paper, 1st quality	100
	Book paper, 1st quality	100

For many grades of wrapping paper, corrugated board liner, etc. the unbleached pulp can be used as 100% of the furnish. For wrappings requiring maximum strength it may be blended with long-fibered sulphate pulps. In some instances long-fibered leaf plants (sisal, hennequin, wild pineapple, etc.) or bamboo may be made available for mixture with tropical broadleaved woods. In such cases, they may be specially processed to yield the long-fibered pulps necessary to impart higher strength to otherwise deficient mixtures.

Suitable uses of tropical broadleaved wood sulphate pulp are listed in table XI:

Recommendations

1. It is urged that silvicultural programs of research in tropical forests be expanded and intensified.
2. The establishment of a new mill should be preceded by a complete field survey carried out by qualified specialists.
3. It is recommended that surveys undertaken be on the largest scale possible with a view to long-term objectives. Less detailed study, which might be influenced by extreme but temporary shortages of paper, may result in hasty preparation with unsound investment.
4. To reduce financial risk it is recommended that only well-tried processes be used and that adequate experimentation on the proposed raw material be executed.
5. Known requirements for the home market rather than the potential demand for export should be the determining factor in planning the capacity for a new mill.

Conclusions

There is adequate laboratory experience and limited industrial experience now available to warrant the conclusion that a wide range of paper products can be made from many tropical broadleaved woods. All the principal pulping processes have some applicability, but few can be applied successfully to complex mixtures of species. Generally, only the alkaline pulping processes—in particular the sulphate process—appear to be suited to tropical broadleaved wood mixtures, from which pulps of a considerable range of utility can be produced.

The acid or neutral processes seem to have limited applicability and can be used only where the species composition of the forest is suitable for such pulping reagents, or where sorting procedures can supply such species from the total yield. Mechanical pulp production appears practical only where the same conditions hold, viz., availability of adequate concentrations of woods suitable for grinding, either as a major forest yield or by sorting from the total. For widespread usage the alkaline processes alone appear to be the most suitable.

It must be insisted, however, the conventional economic analyses may often lead to false conclusions concerning a

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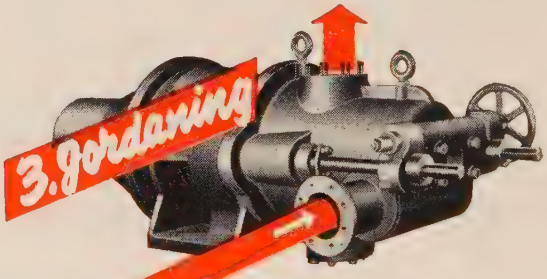

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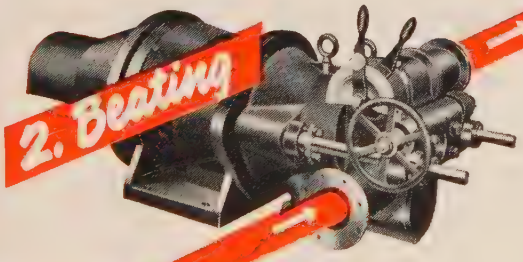

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Cost Data Sheet 14. Raw Material: Bagasse; Process: (a) Sulphate (Unbleached)

(Production cost in U. S. $ per metric ton of slush pulp)

	Unbleached for boards (pulp yield 68%)				Unbleached for wrapping (pulp yield 55%)			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Bagasse, cleaned, m. tons	1.5	10.00	15.00	15.00	1.85	10.00	18.50	18.50
Chemicals, kg.:								
Salt cake	40	0.030	1.20		80	0.030	2.40	
Quicklime	80	0.015	1.20		160	0.015	2.40	
Miscellaneous	..	..	1.50	3.90	..	..	2.00	6.80
Operating expenses:								
Power, kw.-hr.	400	0.008	3.20		400	0.008	3.20	
Steam, m. tons								
Consumed	4.5	..	..		4.5	..	..	
Produced in alkali recovery	3.0	..	..		4.0	..	..	
Net consumption	1.5	1.65	2.48		0.5	1.65	0.83	
Water, m.[3]	100	0.013	1.30		100	0.013	1.30	
Labor, man-hours:								
Operating	5	1.70	8.50		5	1.70	8.50	
Repair	1	2.50	2.50		1	2.50	2.50	
Repair and maintenance materials	..	..	3.00		..	..	3.00	
Factory supervision and overheads	..	..	4.00		..	..	4.00	
Depreciation on plant and equipment	..	..	12.00	36.98	..	..	12.00	35.33
Estimated production cost of slush pulp				55.88				60.63

Notes: (1) Representative price for bagasse in the Caribbean. (2) Estimates based on 50-ton daily capacity plant using full sulphate process, including alkali recovery but excluding lime reburning. (3) Estimated investment in plant and equipment (excluding steam and power): 2.5 to 3.5 million U. S. $. (4) Estimated working capital required: 1.0 to 1.5 million U. S. $.

proposed development. Over-all costs may be high, beyond the price of imported products, but it may also happen—because of currency restrictions, import restrictions, or political considerations—that the cheaper foreign product will not be imported. In such cases, the internal economy of the country may benefit by beginning pulp and paper manufacture at costs involving a temporary fiscal loss. How such losses are to be borne involves matters not within the scope of this publication.

Each individual proposal will present different aspects from others. Transportation costs for chemicals and supplies, the necessity for large investments in developments accessory to the plant itself, the availability of kinds and quantities of wood economically accessible, all these and many other factors will interact to determine the desirability of constructing pulp and paper mills.

A long-term economic point of view may also dictate the desirability of beginning pulpwood utilization both from the standpoint of improving the forest and its yield and furnishing increased employment to the population.

Experimentation henceforward may well be on full plant scale, but carefully planned, organized, and directed.

This planning logically divides into three major stages: (1) the general location of a potential site from the point of view of timber supply, water, transportation, etc.; (2) the accurate inventory and determination of composition of the forest (this cannot be accomplished by aerial survey alone; statistical sampling methods should also be used); (3) laboratory and industrial scale experimentation.

These steps must be preliminary to choice and adaptation of process and planning of the plant, and under no circumstances should be hurried.

Each proposal must be given close scrutiny. General cost estimates should be considered only as a rough guide and each

Cost Data Sheet 15. Raw Material: Bagasse; Process: (b) Sulphate (Bleached)

(Production cost in U. S. $ per metric ton of slush pulp)

	Bleached (purchased chemicals) (pulp yield 48%)				Bleached (electrolytic plant) (pulp yield 48%)			
	Quantity	Unit cost, $	Cost per ton $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Bagasse, cleaned, m. tons	2.10	10.00	21.00	21.00	2.10	1.000	21.00	21.00
Chemicals, kg.:								
Sodium hydroxide	20	0.077	1.54		..	..	..	
Salt cake	125	0.030	3.75		..	..	..	
Quicklime (CaO)	200	0.015	3.00		220	0.015	3.30	
Sulphur	..	..	..		20	0.030	0.60	
Chlorine	70	0.084	5.88		..	..	..	
Salt	..	..	..		130	0.010	1.30	
Miscellaneous	..	..	2.00	16.17	..	..	2.30	7.50
Operating expenses:								
Power, kw.-hr.	500	0.008	4.00		750	0.008	6.00	
Steam, m. tons								
Consumed	6.0	..	..		6.0	..	..	
Produced in alkali recovery	4.3	..	..		4.3	..	..	
Net consumption	1.7	1.65	2.80		1.7	1.65	2.80	
Water, m.[3]	250	0.013	3.25		250	0.013	3.25	
Labor, man-hours:								
Operating	6	1.70	10.20		7	1.70	11.90	
Repair	1.5	2.50	3.75		2	2.50	5.00	
Repair and maintenance materials	..	..	4.00		..	..	5.00	
Factory supervision and overheads	..	..	5.00		..	..	5.00	
Depreciation on plant and equipment	..	..	14.00	47.00	..	..	16.00	54.95
Estimated production cost of bleached slush pulp				84.17				83.45

Notes: (1) Representative price for bagasse in the Caribbean. (2) Estimates based on 50-ton daily capacity plant using full sulphate process, including alkali recovery but excluding lime reburning. Mercury cells in electrolytic plant. (3) Estimated investment in plant and equipment (excluding steam and power): without electrolytic plant, 2.5 to 3.5 million U. S. $; with electrolytic plant, 2.9 to 3.9 million U. S. $. (4) Estimated working capital required: 1.0 to 1.5 million U. S. $.

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Cost Data Sheet 16. Raw Material: Bagasse; Process: (c) Caustic Soda-Chlorine

(Production cost in U. S. $ per metric ton of slush pulp)

	—Bleached (purchased chemicals) (pulp yield 46%)—				—Bleached (electrolytic plant) (pulp yield 46%)—			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Bagasse, cleaned, m. tons	2.15	10.00	21.50	21.50	2.15	10.00	21.50	21.50
Chemicals, kg.:								
Sodium hydroxide	225	0.077	17.33		..	..	..	
Hydrated lime	20	0.015	0.30		20	0.015	0.30	
Chlorine	167	0.084	14.03		..	..	..	
Salt	..	..	..		400	0.010	4.00	
Miscellaneous	..	..	2.00	33.66	..	..	2.50	6.80
Operating expenses:								
Power, kw.-hr.	400	0.008	3.20		1000	0.008	8.00	
Steam, m. tons	2.1	1.65	3.47		3.0	1.65	4.95	
Water, m.³	440	0.013	5.72		440	0.013	5.72	
Labor, man-hours:								
Operating	6	1.70	10.20		9	1.70	15.30	
Repair	2.0	2.50	5.0		2.5	2.50	6.25	
Repair and maintenance materials	..	..	4.00		..	..	6.00	
Factory supervision and overheads	..	..	5.00		..	..	6.00	
Depreciation on plant and equipment	..	..	14.00	50.59	..	..	18.00	70.22
Estimated production cost of bleached slush pulp				105.75				98.52

Notes: (1) Representative price for bagasse in the Caribbean. (2) Estimates based on 20-ton daily capacity plant, without chemical recovery. (3) Estimated investment in plant and equipment (excluding steam and power): without electrolytic plant, 1.2 to 1.7 million U. S. $; with electrolytic plant (diaphragm type cells), 1.5 to 2.0 million U. S. $. (4) Estimated working capital required: 0.3 to 0.5 million U. S. $.

item may be subject to quite broad increases under a specific set of circumstances.

In future experimental work, it is necessary that pulping and papermaking work be correlated with the composition of the forest from which the experimental material comes, in order that a valid estimate of process adaptability may be made. Likewise, an accelerated program of silvicultural research in tropical broadleaved woods is highly desirable in order that a prospective operation may be equipped with knowledge as to yields and species and, above all, the practices that will insure a perpetual supply of suitable species.

It appears that there are now important but limited possibilities for beginning new pulp and paper operations based on tropical broadleaved woods. As industrialization of underdeveloped countries proceeds, it will be to some extent accelerated by the availability of paper and, in turn, it may be expected that industrialization will increase the availability of chemicals and equipment for pulp and papermaking.

Straw

Introduction

Straw was employed in making pulp for paper long before wood was used, but methods were primitive, and cardboards and low-grade wrapping papers were the main products. Progress in the straw pulp industry was slow and was gradually superseded by the wood pulp industry, although many small straw pulp mills from the early period are still in operation.

Today, total production of pulp from straw amounts to about 1 million tons a year, or some 3% of the world's wood pulp production.

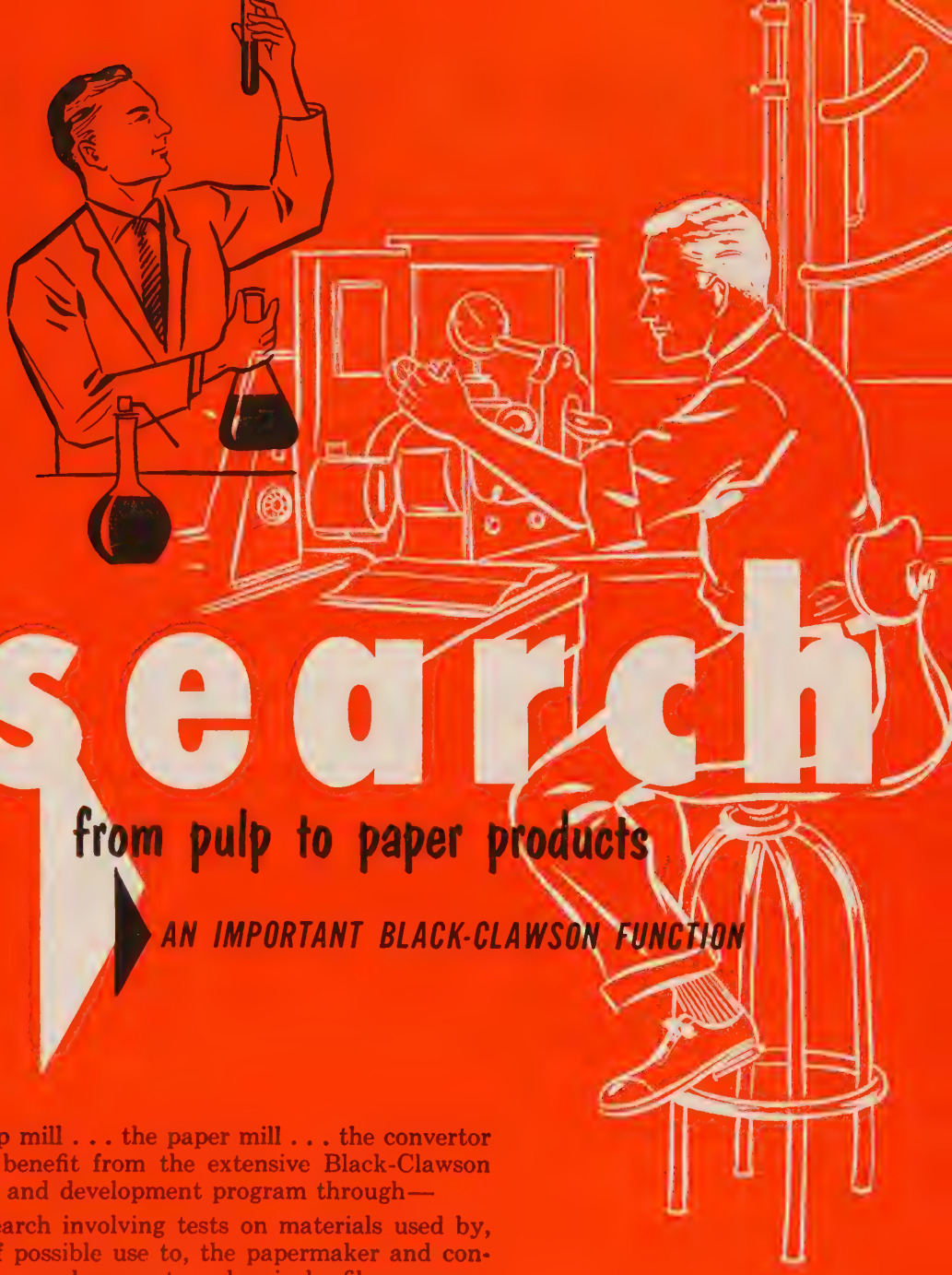
Improvements of production techniques have allowed finer grades of pulp to be produced from straw by the soda, sulphate, caustic soda-chlorine, and neutral sulphite processes. Products of these processes are approximately equal in strength to coniferous wood sulphite pulps, although they have not

Cost Data Sheet 17. Raw Material: Bamboo; Process: Sulphate

(Production cost in U. S. $ per metric ton of slush pulp)

	—Unbleached (pulp yield 50%)—				—Bleached (pulp yield 40%)—			
	Quantity	Unit cost, $	Cost per ton, $	Total, $	Quantity	Unit cost, $	Cost per ton, $	Total, $
Bamboo, cleaned and chipped, m. tons	2.0	24.00	48.00	48.00	2.5	24.00	60.00	60.00
Chemicals, kg.:								
Sodium hydroxide	..	..	..		20	0.077	1.54	
Salt cake	90	0.030	2.70		120	0.030	3.60	
Quicklime (CaO)	200	0.015	3.00		250	0.015	3.75	
Chlorine	..	..	..		70	0.084	5.88	
Miscellaneous	..	..	2.00	7.70	..	..	2.50	17.27
Operating expenses:								
Power, kw.-hr.	400	0.008	3.20		500	0.008	4.00	
Steam, m. tons								
Consumed	4.5	..	..		6.0	..	..	
Produced by recovery	4.0	..	..		4.3	..	..	
Net consumption	0.5	1.65	0.83		1.7	1.65	2.80	
Water, m.³	100	0.013	1.30		250	0.013	3.25	
Labor, man-hours:								
Operating	5	1.70	8.50		6.0	1.70	10.20	
Repair	1	2.50	2.50		1.5	2.50	3.75	
Repair and maintenance materials	..	..	3.00		..	..	4.00	
Factory supervision and overheads	..	..	4.00		..	..	5.00	
Depreciation on plant and equipment	..	..	11.50	34.83	..	..	14.00	47.00
Estimated production cost of slush pulp				90.53				124.27

Notes: (1) Estimates based on: (a) reported price for bamboo in India, but with conventional U. S. process cost data; (b) 50-ton daily capacity plant, including alkali recovery but excluding lime reburning. (2) Estimated investment in plant and equipment (excluding steam and power plant): 2.0 to 3.5 million U. S. $. (3) Estimated working capital required: 1.0 to 1.5 million U. S. $.



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quite the tear resistance of the latter. After bleaching, straw pulps made by these processes may be used for the manufacture of writing and printing papers.

Annual production of wheat straw in the world is approximately 350 million tons. Of this amount, only 2 million tons, or less than 1%, are used as a pulping material. This situation is explained by the following facts: (1) production of straw is spread over wide areas and furthermore the material is bulky and requires baling for long-distance transportation; (2) supply and prices fluctuate from year to year, depending upon the crop and other circumstances; (3) collection of sufficient good quality raw material (without dirt) needs efficient organization and equipment and long-term contracts.

If only 10% of the annual world wheat straw production could be made available for pulp, it would provide sufficient raw material for the production of 15 to 20 million tons of pulp a year.

In addition to wheat straw, another potential pulping material is rice straw produced in tropical and subtropical regions. Before World War II, white papers of a high quality were made in Java from 100% rice straw. The two Javanese mills in operation today together have a capacity of 40 tons a day. To utilize rice straw, it would be necessary to organize economic collection; pulp mills would have to compete with certain agricultural users for the straw.

In considering straw as a raw material, certain limitations must necessarily be kept in mind; changing farming techniques (e.g., increased use of combine harvesters) and the production tendency toward short-straw varieties may reduce supplies available.

Raw Material

Supply. Straw, a co-product of grain production, is available wherever grain is grown. In the United States the yield of straw can, according to Aronovsky, be calculated from grain production figures in the following way:

Wheat—2.6 tons of straw per ton of wheat (70 tons of straw per 1000 bushels)
Rye—3.5 tons of straw per ton of rye (87 tons of straw per 1000 bushels)
Oats—1.8 tons of straw per ton of oats (26 tons of straw per 1000 bushels)
Barley—1.6 tons of straw per ton of barley (35 tons of straw per 1000 bushels)
Rice—1.4 tons of straw per ton of rice (34 tons of straw per 1000 bushels)
Flax—3.3 tons of straw per ton linseed (84 tons of straw per 1000 bushels)

It is estimated that only about 50% of the straw grown is generally recoverable for farm and nonfarm use. This percentage varies with requirements and cultural practices of different localities. The remainder, including stubble, short straw, and chaff is left on the ground or ploughed under to supply humus and plant food. In some of the more densely populated arable areas a larger proportion of the recoverable straw is used for fuel. A considerable amount of straw is used for cattle feeding and bedding and ultimately returned to the soil as manure. It must be emphasized that only that portion of cereal grain straw which is surplus to farm needs can be considered for industrial utilization. Where good agricultural practice requires these materials for litter and bedding or for the soil, such uses must be considered foremost.

While often it may be economic to obtain straw from areas up to a radius of 160 km. (100 miles)—or even further where water transport is possible—the ideal radius is normally considered to be about 50 km. (30 to 35 miles). The development of mechanical straw balers has solved the problem of straw collection. The average price of straw at the mill in the United States is $12 to $16 per ton, of which about $3.00 go to the farmer for standing straw in the field, $2.50 to $4.00 for baling, and the rest for transportation. The price in Europe usually varies between $10 and $15 per ton at the mill.

Chemical Composition. Straw is characterized by its open structure, its low lignin content (17 to 19%), low alpha-cellulose content (33 to 38%), and high hemicellulose content (27 to 32%). The ash content is generally high (4 to 8%), and consists chiefly of silica. The silica content, however, varies greatly not only between different species, but also within the same species from one locality to another. Rice straw has an outstandingly high ash content (16 to 19%).

Due both to low lignin content and open plant structure, straw is easy to pulp. The pulping reaction is rapid and chemical requirements are lower than for other fibers.

Keeping in mind the high content of hemicellulose, which is easily hydrolyzed, and the open structure, which facilitates hydrolysis, it seems reasonable not to pulp straw by the acid sulphite process. The alkaline processes will undoubtedly give higher yields and stronger pulps.

Fiber Dimensions. The cells or fibers from the internodes form the major part of straw pulp. They are comparatively short and slender. The average diameter is about 13 mu (coniferous wood fibers 30 to 40 mu) and the average fiber length about 1.0 mm. The straw fibers are thus shorter than those of coniferous woods (2.7 to 3.6 mm.) and approximately as long as the fibers from broadleaved woods.

Straw pulp also contains parenchyma and serrated cells, platelets, vessels, and spirals—all being small and relatively nonfibrous. They come mainly from the vestige of pith on the inner part and from the epidermis of the stem, from the nodes and ears, the leaf blades, and from the chaff.

Processes Used in Current Practice

Preparation and Cleaning. In many mills in Europe the straw is cleaned before it enters the digesters; in the United States, however, such a treatment is the exception. Bales of straw are fed continuously to a cutter, the loose fines and dust being removed by separation in a cyclone.

While many mills send the straw straight to the digesters from this point, some mills—producing bleached pulp—carry the cleaning process further. In these the precleaned straw is treated in a thresher or beater, which loosens additional dirt and fines, and this dirt, together with nodes and grain, is removed by means of screens. This treatment results in a loss of about 5% of the straw.

It is not, however, necessary to resort to such elaborate cleaning even for bleached pulps. In certain mills, nodes, grain, and remaining dirt are removed after the straw is cooked by means of screens, rifflers, vortraps, etc. By using the latter method it is moreover, possible to obtain higher overall yields of pulp, based on the dry weight of the straw as received.

Results of investigations carried out in Holland have indicated that the presence of the node elements in the final pulp is not detrimental. Thus, merely dirt and dust may be removed from the straw, and the nodes—separated from the pulp by screening—returned to the digester room for recooking.

Lime Process. The traditional lime process, with rotary globe digesters, is still used widely for straw pulping. Large quantities of strawboard and low quality wrapping paper are produced by this method. It is employed in France and Italy by a great number of small plants each of which produces quantities of from a few hundred pounds to 2 or 3 tons of pulp per day. In other European countries and in the United States the mills are fewer in number but larger in size, many producing more than 100 tons per day. The straw is usually cooked with 8 to 10% lime at temperatures of 100 to 140°C.

Most of the mills which use the lime process do not wash the pulp after cooking; thus it goes to the paper machine with all the fines and residual chemical present. While such prac-

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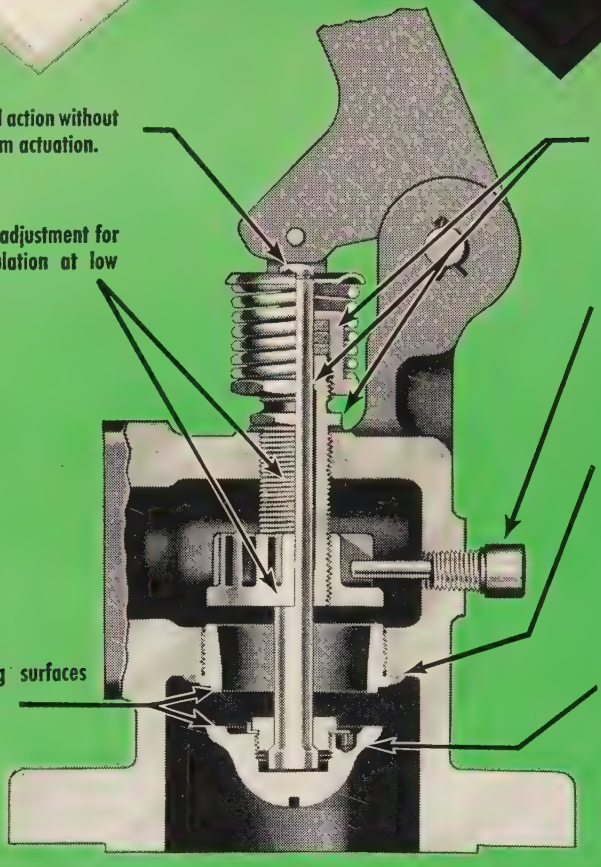
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PAPER

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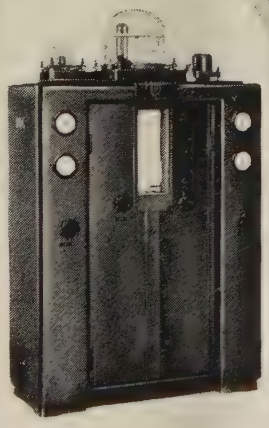

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1-50

tice results in very high yields (up to 85%) the quality of the product is low and the paper can be neither bleached nor sized. Nevertheless it finds extensive use in the manufacture of several kinds of boxes and shipping containers.

Soda Process. The conventional soda process is used in some mills—especially in Holland—for the production of a higher quality board than that given by the lime process. Moreover, it is by far the most widely used process for the production of bleached straw pulp. Many such mills are operating in Germany, often on a small scale. The cooking is usually performed in rotary globe digesters with 12% caustic soda for 5 hr. at 160°C. The pulp is given a one-stage hypochlorite bleach, with a resultant yield of about 40%.

During the recent war, when supplies of esparto grass from North Africa were cut off, the majority of esparto mills in the United Kingdom turned to straw as a source of fibrous raw material. As much as 120,000 tons of bleached straw pulp per year were produced by the soda process in these mills. When esparto became available again after the war, however, the production of bleached straw pulp by the conventional soda process decreased.

Sulphate Process. So far as is known the Phoenix mill in Holland, with a capacity of 15,000 tons per year, and one or two mills in Germany, are the only mills in the world using the sulphate process for pulping straw. At the Phoenix mill the only cleaning operation on the dry straw prior to digestion involves separation of the residual grain. The straw is cooked by the regular sulphate process and digestion is followed by complete cleaning and bleaching. Yield is about 40%, and, except for tear resistance, the pulp is comparable to high quality bleached wood pulp.

A complete sulphate liquor recovery process is employed. Although the general belief is that a chemical recovery system will not work satisfactorily when using a raw material such as straw, which has a high silica content, the Dutch mill has been using the kraft recovery system for many years. It should be mentioned, however, that the bulk of the raw material in this case consists of rye straw from light sandy soil. This straw actually has a low silica content (about 1% or less) by comparison with wheat straw from heavy clay soils which contain as much as 6% silica.

Caustic Soda-Chlorine Process. This process, which is continuous, uses no pressure vessels, but open towers with buffer tanks in between. Primary delignification is obtained by treatment with a weak caustic soda solution in a steam-heated tower.

The digested raw material thus obtained is used for the manufacture of corrugating medium, boards, and some types of wrapping papers. Such semipulps can be bleached to a creamy white color in a single stage with hypochlorite, and are then suitable for addition to newsprint, envelope, and other furnishes.

In making semipulp, the raw material is soaked in a 2% solution of caustic and digested in the tower at a liquor/straw ratio of about 3:1 for approximately 1 to 1.5 hr.

For making fine bleached pulp, the straw is soaked in a 3% caustic solution and the digested material then washed, pressed to a consistency of about 30%, followed by fluffing in an opening machine, and eventually passed through a tower (about 20 to 30 min.) into which chlorine gas is injected. After chlorination the pulp is submitted to caustic extraction, screened, and then bleached in one or two stages with hypochlorite. The first fine pulp mill to use this particular process was started in Italy in 1922. Whereas the earlier mills, particularly those in countries having no chemical industry, used the complete output of an electrolytic chlorine plant, some now purchase their individual requirements of chlorine and caustic soda.

Neutral Sulphite Process. The neutral sulphite process is also suitable for the production of board and fine paper pulps. For the production of the latter it has found its widest use in Italy. At least seven mills, producing both unbleached and bleached pulps, are in operation there. Some alkali (caustic soda or sodium carbonate) is added together with the sodium sulphite in order to prevent the reaction of the cooking liquor from becoming acid during the course of digestion. In the largest and most modern of the Italian mills, the chemical solution for cooking is added in a separate mixing and dosing chamber before the straw actually reaches the digesters. The particular method employed provides for thorough mixing of chemicals with the straw and allows complete filling of the digesters.

Cooking is carried out with 10% sodium sulphite and 5% caustic soda—based on the dry weight of the straw—at 160°C. for about 8 hr. It is claimed that with the straw available in Italy the common neutral sulphite process (using less caustic soda or sodium bicarbonate as buffering agent) is not satisfactory, but that about 5% caustic soda has to be added. The spent liquor is not recovered. The yield of unbleached pulp is about 50%.

After cooking, the pulp is defibered and cleaned over rifflers, screens, and centrifugal separators. In all these operations more and more of the fines are washed away and removed, leaving good fibrous pulp.

The pulp is bleached with hyprochlorite in Hollanders in a one-stage bleaching operation using about 5% available chlorine. The yield of bleached pulp is approximately 42%, based on the dry weight of the straw received. This is in contrast to yields of 50% obtained in laboratory operations. Some of this loss is due to the large amount of material removed in cleaning the straw as well as washing and screening the pulp, and no doubt some additional loss results from the use of much caustic soda in the cooking liquor.

A mill in Holland with an annual capacity of 15,000 tons uses the neutral sulphite process with a ratio of sulphite to caustic soda of about 5:1. The unbleached pulp is chiefly used for the production of folding grade and other kinds of boards. Quite recently, however, a complete continuous Kamyr bleaching system has been installed and now only fully bleached pulp is sold on the open market. Other neutral sulphite straw mills are under construction in France, Greece, and Denmark.

Cold Caustic Soda Process. One mill in Italy produces straw pulp and converts it into glassine paper in a completely integrated operation. A unique cold caustic soda process is used which requires 10 to 12% caustic soda and a period of about 15 days to complete the reaction. Part of the pulp is bleached by one-stage hypochlorite. Both unbleached and bleached pulp are used for glassine either alone or in blends with bleached sulphite wood pulp. Straw pulp so made is particularly suitable for glassine paper because of the high hemicellulose content resulting from extremely mild digestion.

Mechano-Chemical Process. In the mechano-chemical process either soda or sulphate process chemicals may be used. The pulping operation, instead of being conducted in digesters under steam pressure, is done in a hydrapulper at atmospheric pressure and a temperature of 98°C. The process is carried out by charging the hydrapulper with hot cooking liquor starting circulation, and adding the straw as rapidly as possible. Direct steam is used with a total cooking time of from half an hour to one hour. Defibering may be completed in the hydrapulper or, if necessary, the pulp may be passed through a disk refiner. The pulp may be used either unbleached or bleached.

Products[32]

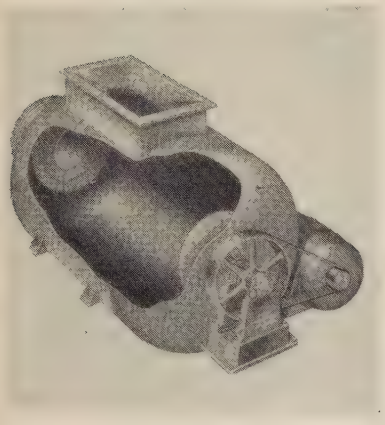
Due to short and thin fibers and high hemicellulose content, straw pulps in general form dense papers with low tear resistance and low opacity.

[32] For detailed table showing possible uses of straw pulps see Chapter IV (Table VIII).

FOR STOCK PREPARATION

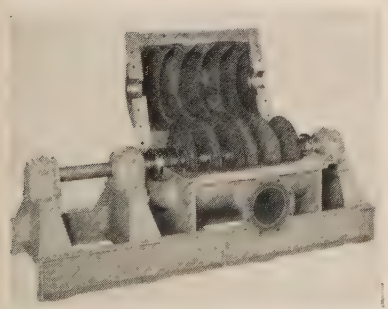
Rice Barton Dyno Machines

The DynoPulper



The QuatroPulper

The DynoFiner



These machines are used in preparing stock ahead of paper machines, in the elimination of beaters for working up broke, waste papers, de-inking systems and for the preparation of pulp. Completely separate fibres without cutting or shortening and with little or no appreciable drop in freeness. For heavy production — the **QuatroPulper** — for medium volume — the **DynoPulper.**

DynoPulper—made in 3 sizes for 500 to 1500 lbs. per charge at 4% consistency. Processes material at a consistency from 3 to 6%. Completely separates fibres without cutting or shortening.

QuatroPulper—for 2000 to 6000 lbs. per charge.

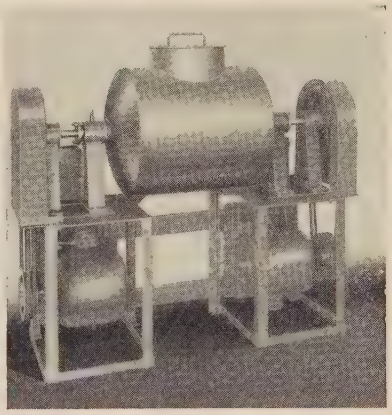
DynoFiner—for completing the process of de-fibering slush pulp on a continuous basis at the rate of 100 tons per day.

Pilot Model — for semi-commercial operation.

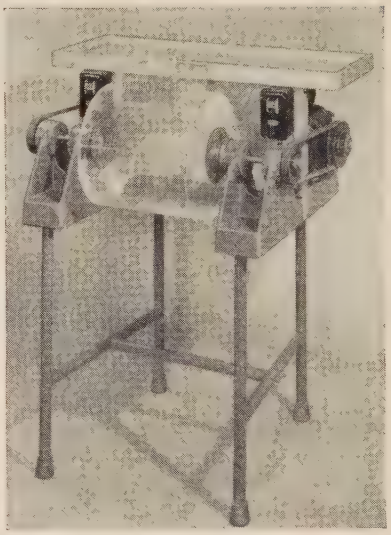
Lab Model—for laboratory work.

Dump Valves—from 4″ to 14″, designed especially for use with Dyno machines. No pockets on top—passages of valve are clear, smooth and unobstructed. Made up in cast-iron, bronze or stainless steel.

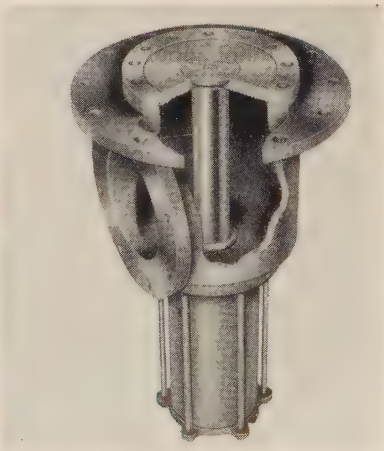
Pilot Model DynoPulper



Lab Model DynoPulper



Dump Valves



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When blended in suitable proportion with coniferous wood pulps, straw pulps will improve sheet formation, surface characteristics, and printability. They may be recommended for use in papers such as writing and bond, tablet, ledger, and book. They may also replace part or all of the coniferous wood sulphite in newsprint and magazine book papers, where their addition will increase strength and improve formation.

From straw pulp it is possible to make greaseproof and glassine papers possessing good transparency and resistance to grease and oil. The tear resistance of such papers might be improved by blends of coniferous wood or other long fiber pulps. Good writing and printing papers may be made wholly from straw pulps, but fillers are generally required to obtain the desired opacity. If used alone they are not suitable for strong wrapping and bag paper, but when mixed with coniferous wood pulps they may be used for many qualities. Unbleached semichemical straw pulps are well adapted for 9-pt. corrugating papers.

Recommendations

1. Prior to the erection of any straw pulp mill, it is essential to establish that the necessary raw material is available in sufficient quantity in perpetuity and that it may be collected, stored, and preserved at reasonable cost.

2. In choosing the process to be applied and the products to be made, the general technical and educational level, and the market conditions in the country under consideration should be most carefully considered. As a general rule, the local market should be the determining factor in planning a new mill.

Conclusions

Wide industrial experience has shown that various cereal straws are suitable raw materials for corrugating medium and solid fiberboards as well as for medium quality wrappings and for good quality writing and printing papers. For better quality wrappings, and for writing and printing papers, admixture with other types of pulp is generally necessary.

Extension of straw pulp production appears to have been hampered far more by difficulties of raw material supply than by any technical reason.

Sugarcane Bagasse

Introduction

Bagasse is the waste fibrous product resulting from the milling of sugar cane to extract the juices. As it comes from the cane mill it has a moisture content of from 45 to 52%. It contains from 1.5 (in best practice) to as much as 4% of sugars (in poor practice). With relatively minor exceptions, bagasse—from the inception of the cane sugar industry—has supplied all of the industry's fuel requirements.

As engineering and boiler efficiency have been improved, there is now an excess of bagasse in most modern mills, to a large extent in the case of raw sugar and to a smaller extent in the case of refined sugar. If no other large-scale use is found for this excess it is simply burned, and the heat generated wasted.

Raw Material

Supply. A practical estimate of the amount of bagasse produced is to assume 1 ton of moisture-free bagasse per ton of raw sugar output.

Table XII has been prepared on this basis, and the huge supply of bagasse shown amounting to 25 million tons appears, on the surface, to be a tremendous source of cheap fibrous raw material for the production of pulp and paper. *However, to consider the total quantity as being available is misleading because there is a great demand for most of this material as fuel for the sugar mills,* the high heat value of dry bagasse being about 8000 to 8600 B.t.u. per lb.

When making raw sugar, all the bagasse is not required for fuel. A large mill, for instance, may have a *surplus* of some 25%. There are, however, numerous raw sugar mills where all the bagasse is used for steam production; some mills even use wood or other fuel in addition. In general, the smaller the size of the mill, the less surplus bagasse is available, chiefly because of low boiler efficiency. Many sugar mills are small and from a pulp and papermaking standpoint their *entire* supply of bagasse could not support a unit of economic size. The procurement of bagasse from other mills in the same region may or may not be practicable.

Table XII. World Availability of Sugarcane Bagasse in 1951

(In thousands of short tons)

Africa		1,747
Asia		4,357
India	(1600)	
Philippines	(1100)	
Oceania		1,030
South America		3,864
Argentina	(760)	
Brazil	(1900)	
United States and territories		3,127
Hawaii	(1100)	
Louisiana	(500)	
Puerto Rico	(1400)	
Other North American and Central American Countries		10,668
Cuba	(8000)	
Dominican Republic	(700)	
Mexico	(850)	
World total		24,793

Note: Figures in parentheses denote main concentration of supplies.

Furthermore, any substitution of bagasse by other fuels would involve capital expenditure on the part of the sugar mills, not only for replacement of boiler plant, but also for handling and storage of the other fuel concerned.

The cost of bagasse as a raw material for pulp and paper therefore depends entirely on the technical situation of the mills in the district under consideration.

Baling and Storage. Sugar mills, except in a few countries, operate to grind cane from 3 to 6 months. In order to make bagasse available for year-round pulp and paper production, it must be baled and stored. No new technical problems are involved in these operations which have been successfully carried out in several countries for years, but nonetheless they do involve considerable working capital and operating expense.

The total cost of baling and storage will vary depending on several factors, but $5.00 to $8.00 per dry ton is perhaps an average figure.

Composition. Physical: Bagasse varies widely in its physical and chemical composition. Such differences are due to the varieties of cane grown, the effects of climatic conditions, and the way the cane is crushed in each particular sugar mill. The crude fiber content may range from less than 10 up to 5%. Two quite distinct elements are found in the sugar cane plant, namely pith and long fiber. The proportion of these also fluctuates in different varieties. For practical purposes, however, it may be assumed that dry bagasse has the following approximate composition:

Water solubles and dirt, %	10 (approx.)
Pith, %	25 (approx.)
Fiber, %	65 (approx.)

The average length of the fibers is between 1.5 and 2 mm., some being as long as 3.5 mm. Thus bagasse fibers on average are longer than broadleaved wood fibers and straw fibers diameter is about 20 mu. The pith cells are small and nonfibrous.

Interior of Lukens Inconel-Clad steel digester, manufactured for Crossett Paper Mills by Wyatt Metal and Boiler Works, P.O. Box 3052, Houston 1, Texas. Since its installation some 3½ years ago, annual corrosion is nil.

Digester corrosion rate:
Inconel, nil—Carbon Steel, 62 mils

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They have used various forms of carbon steel and different alloys including Lukens Inconel-Clad for digesters.

Eight mild steel digesters show an average corrosion rate of 62 mils per year. The Inconel-Clad digester shows no measurable corrosion.

The evidence is clear, not only in the Crossett installation but in several other well known mills.

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Chemical: The chemical composition of the pith and fibrous material in sugar cane bagasse is given below:

Percentage of	*Pith*	*Fiber*
Ash	5	2
Lignin	19	19
Alpha-cellulose	32	38
Pentosans	32	32

Processes Used in Current Practice

Preparation—Removal of Pith. There have been many ventures to produce pulp and paper from bagasse but until recently none of these was successful. This was partly due to lack of thorough preliminary study, technical knowledge, and underestimate of investments; but a misunderstanding of the pulping of pith, as contrasted to fiber, was also a contributory factor. It has been established that higher quality products may be made from pulp relatively free from pith. The pith material can partially be removed by chemical digestion, and excessive washing and bleaching, but this operation can be costly and will eliminate only part of the pith. In addition, pulps made in this manner are slow running and produce brittle, hard papers. More pith is removed by prehydrolysis, though this is a two-stage pulping operation, and results in high operating costs.

Opinion today is directed more toward removal of pith from the raw material before pulping, and both dry and wet methods have been developed for this purpose.

Up to now the pulping processes mainly used on a commercial scale are: soda (or sulphate), caustic soda-chlorine, neutral sulphite, and mechano-chemical.

Soda Process. The bagasse is cooked with a solution of caustic soda in pressure digesters in a manner similar to the process used for wood. The consumption of caustic is between 10 and 15% on moisture-free bagasse and the cooking temperature is held at 160°C. for several hours. Unbleached pulps may be used for corrugating medium and boards and are suitable for lower quality wrappings. Brown stock may be easily bleached, the resulting pulp being used particularly in blends for fine writing and printing papers.

Sulphate Process. The sulphate process uses liquor containing caustic soda and sodium sulphide, but digestion conditions are otherwise similar to those of the soda process, somewhat higher yield and better physical characteristics being obtained. A modified sulphate process has been used by a mill in Peru for a number of years, this process utilizing caustic soda and sulphur to produce a sulphate-type pulp. Addition of an alkali recovery system would convert such a plant to a full sulphate mill. Pulps from this mill, blended with imported sulphite and sulphate pulps, have been used in the manufacture of paperboards, liner boards, sack and wrapping papers, and medium quality printing papers.

Caustic Soda-Chlorine Process. This process, which is continuous, uses no pressure vessels, but open towers with buffer tanks in between. Primary delignification is obtained by treatment with a weak caustic soda solution in a steam-heated tower. The digested raw material thus obtained is used for the manufacture of boards and some types of wrapping papers.

Such semipulps may be bleached with hypochlorite to a creamy white color in a single stage, and are then suitable for addition to newsprint furnishes, envelope papers, etc.

For making bleached pulp, the digested material is washed, pressed to a consistency of about 30%, followed by fluffing in an open machine, and passed through a tower (about 20 to 30 min.) into which chlorine gas is injected. After chlorination the pulp is submitted to caustic extraction, screened and finally bleached with hypochlorite in one or two stages.

Neutral Sulphite Process. This process uses sodium sulphite as the principal chemical but the cooking liquor at the end of the cook must be kept slightly alkaline to prepare the best pulps. In order to arrive at this result either sodium hydroxide or sodium carbonate is used. The neutral sulphite process differs from the alkaline processes in that the hemicelluloses are not so readily attacked and removed, thus leading to somewhat higher pulp yields.

The course pulps are used for corrugating board, solid fiberboard, folding boxboard, and liner board, the latter being best made by blending the bagasse with coniferous wood sulphate pulps. The bleached pulps may be used as a 100% furnish in the manufacture of greaseproof and glassine. In the case of all kinds of fine writing and printing papers, however, they are generally used in admixture with other pulps.

Mechano-Chemical Process. This process consists of pulping bagasse in a hydrapulper or similar machine at atmospheric pressure. The temperature is raised to 98°C. for from 30 to 90 min. depending on the raw material and type of pulp desired. The hydrapulper must be supplied with an oversize rotor and with a more powerful motor than is used for pulping waste papers. Consistency at the beginning should be as high as possible, and at least 10 to 12%. At the end of pulping, consistencies may range from 6 to 8%.[33]

From 8 to 16% chemical is required (depending on product) and from 45 to 80 min. pulping time. The hot pulp from the hydrapulper may be refined, then screened, the screenings being returned to the next cook. The fine paper pulps may be bleached to a brightness of 70 with 8 to 10% chlorine, and to 80 brightness with 10 to 15%, depending on the raw material. Bleaching is carried out by a three-stage process.

The unbleached pulps may be used for high-grade corrugating liner or coarse wrapping, while the bleached pulps may be used for a wide variety of fine papers. Their use, however, is in blends with other pulps.

The process is exceedingly simple to control and very rapid. The high strength of the pulps is attributed to the fact that the mild conditions employed do not degrade the cellulose and hemicellulose so much as pressure cooking.

Products[34]

With the exception of coarser grade material, such as corrugating board, it is essential to separate a large percentage of the pith from the bagasse fiber if a good quality product is to be made on modern high-speed machines. This is particularly true in the case of bleached pulp. Bagasse fibers are short and thin and the hemicellulose content is comparatively high, so that pulps in general made from this material form dense papers with low tear resistance and low opacity. In the case of strong wrapping and bag papers, they must be mixed with long fiber pulps. It is possible, however, to make good greaseproof and glassine papers from them alone.

When blended in suitable proportion, bagasse pulp will improve sheet formation, surface characteristics, and printability. It may be recommended for use in papers such as writing and bond, tablet, ledger, and book, and may also replace coniferous wood sulphite in newsprint and magazine book papers. Unbleached bagasse pulps are well adapted for corrugating medium.

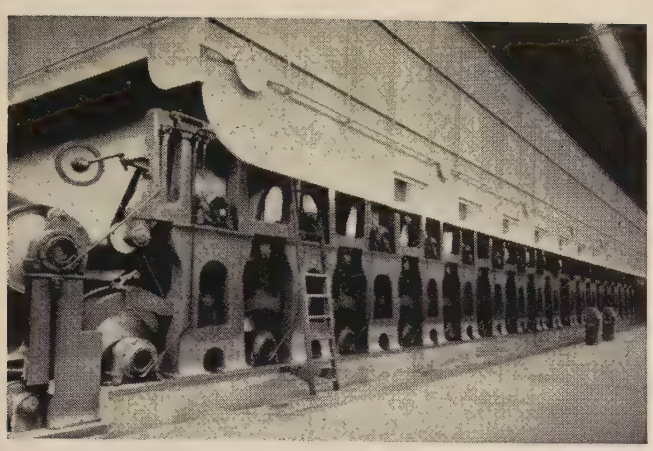
Recommendations

1. Any proposed project should be thoroughly examined by qualified specialists in order to avoid technical failure or an underestimate of the investment cost.

2. In general, in underdeveloped countries attention should be directed to the manufacture of unbleached pulps to make wrapping and container papers for the local market.

[33] The hydrapulper extraction plate should be replaced with a solid plate, and a large discharge line with quick opening valve is required for rapid discharge of pulp.

[34] For detailed table showing possible uses of bagasse pulps see Chapter IV (Table VIII).



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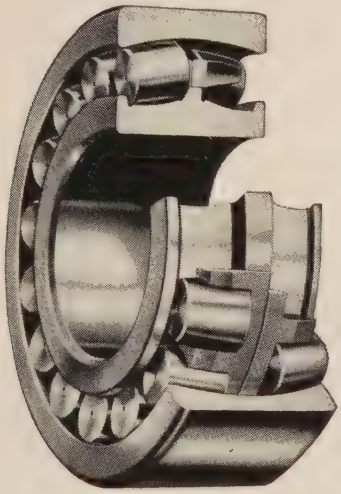

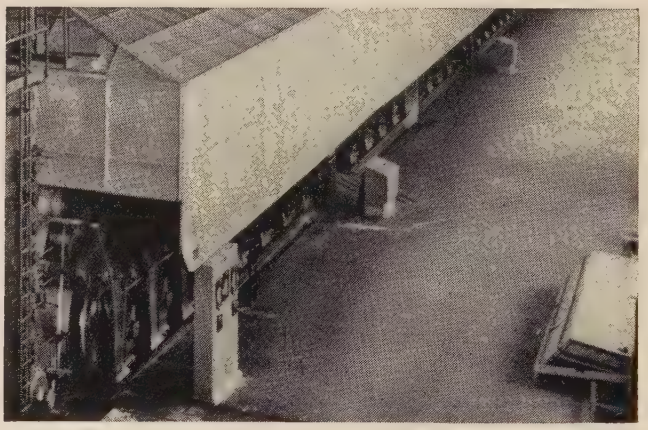

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3. Known requirements for the local market, rather than the potential demand for export, should be the determining factor in planning the capacity for a new mill.

4. With the difficulties inherent in establishing any new industry, particularly one as specialized as pulp and paper, in underdeveloped tropical countries consideration of new or secret processes merely involves unnecessary additional risk and should be avoided.

Conclusions

Bagasse pulp is being used to manufacture a wide variety of paper many of which may be made wholly from it. Grades requiring mechanical strength need admixture with long-fibered pulps.

Sugar mills in favorable locations may find it profitable to convert the surplus bagasse into pulp and paper, but this depends largely on local factors.

Pith removal from bagasse as well as handling and storage are problems which have been met and solved in several operations, and pulping processes are available to make highly satisfactory grades of pulp.

Research on the utilization of pith has been active for many years and continues. However, the successful operation of a bagasse pulp mill need not be tied to the economics of large-scale pith utilization, since pith may still be burned in the mill boilers and its fuel value recovered.

Bamboo

Raw Material

Supply. Although bamboo mainly occurs in the tropics, it also grows in other areas. One great advantage that bamboo has over coniferous is that a culm of about three years' growth is suitable for pulping, whereas most coniferous woods require much more time to develop. In India, abundant supplies of bamboo are available in Assam, Bengal, Bihar, Orissa, Madhya Pradesh, Bombay, Mysore, Hyderabad, Madras, and Travancore.

It has been observed in India that a bamboo culm gives rise to one or two new shoots in the first year of its growth and sometimes one more shoot in the second year. It does not usually produce any more shoots after the second year. Hence, a bamboo culm is not felled before it is 2 years old. A felling cycle of 3 to 4 years is the usual practice, and, as a rough estimate, the yield of bamboo per acre per year is about 0.75 ton.

Dendrocalamus strictus is the predominant species in India. *Bambusa arundinacea* is found in the Deccan. Other species used for the manufacture of paper are *Dendrocalamus hamiltonii, Bambusa balcooa, Bambusa mutans, Bambusa vulgaris, Bambusa tudla, Melocanna bambusoides, Ochlandra travancoria,* and *Ochlandra rheedii.* The latter two species grow in Travancore and are generally known by the local name of eta reeds.

Bamboo is used for a large number of purposes. It is poor man's timber, and is used in villages for building walls and roofs of huts. Curtains, baskets, chairs, base material for umbrellas used by villagers, boxes, and various articles for domestic use are also made from bamboo.

On the industrial side, bamboo forms one of the two major fibrous raw materials for the Indian paper mills, the other on being sabai grass (*Eulaliopsis binata*). Annual usage of bamboo and sabai grass for papermaking amounts to about 225,000 and 80,000 tons (air-dry basis) which represents 60 and 22% respectively, of fibrous raw materials consumed by the industry.

Anatomical Structure. The wall of the stem is built up of the following main elements, all running parallel to the axis of the stem: parenchymatous tissues, vessels, fibers, sieve tubes, and annular vessels.

The various elements lie longitudinally in close juxtaposition to each other with very few air cavities (intercellular spaces) between them.

The air cavities are mostly confined to the lumina of the various cells and vessels, which, therefore, form the gross capillary system of bamboo. Determination of the apparent specific gravity of a dry block of bamboo stem and of absolute specific gravity of bamboo substance has shown that approximately 60% of the total volume consists of air cavities. The fiber-vascular bundles are concentrated mainly in the region near the outer wall of the stem and constitute about 65% by weight of the total stem.

In the case of uncrushed bamboo chips, the passage of cooking liquor during digestion to the middle lamella is more difficult than in the case of wood chips. In the latter, the presence of bordered pits, medullary rays, and the existence of more intercellular spaces is a great help in facilitating the passage of cooking liquor. Such characteristics are absent in bamboo, and therefore the stems are crushed before digestion, in order to aid penetration of cooking liquor.

Chemical Composition. The chemical composition of bamboo varies not only between different species but also within the same species from different places. Results of chemical analysis of bamboo are given below. These show the range of values for various species used in the Indian paper industry.

Constituents	*Per cent on moisture-free weight of bamboo*
Ash (with silica)	1–3
Silica	0.5–2.0
Cold water solubles	3–7
Hot water solubles	4–8
Alcohol-benzene solubles	0.3–2.0
1% NaOH solubles	17–23
Pentosans	16–21
Lignin	22–30
Cellulose (Cross and Bevan)	57–63

Fiber Dimensions. Bamboo yields long-fibered pulp. The fiber length depends upon the species. The average fiber length of *Dendrocalamus strictus* is about 3.0 mm., the minimum and maximum values being 1.0 and 5.5 mm., respectively. The Indian bamboo having the longest fibers is *Ochlandra travancorica;* the average fiber length is 4.0 mm., the minimum and maximum values being 1.0 and 9.0 mm., respectively.

Processes Used in Current Practice

Preparation. For reasons explained earlier, bamboo stems are crushed before digestion. Heavy crushers of the type employed in the sugar industry are used, with generally a set of three crushers. These are placed at different levels in such a way that the stems pass continuously from one crusher to the next one below it. On passing through the last crusher, the stems are not only crushed but also broken into small pieces, the pieces then being sorted on a two-deck sieve. Bigger pieces which are later reduced to a smaller size in a hammer mill or cutter, are retained on the top sieve and the dust and fines pass through the bottom sieve. The crushed pieces retained on the lower sieve are taken from digestion together with the pieces of required size prepared from the bigger ones.

Sulphate Process. In India, bamboo pulps are manufactured in the same mill as that for the final paper. The bamboo is digested by the sulphate process except in one mill which uses the sulphite process. Generally a "fractional" or two-stage method is used for the production of bleachable pulps but an "overhead" or one-stage method is preferred for unbleached pulp for wrapping paper.

In the "fractional" method, digestion is carried out in two stages, the spent liquor from the second stage being used as cooking liquor for the first stage. The material to liquor ratio is about 1:4. The first-stage digestion is carried out at

Good Bleaching

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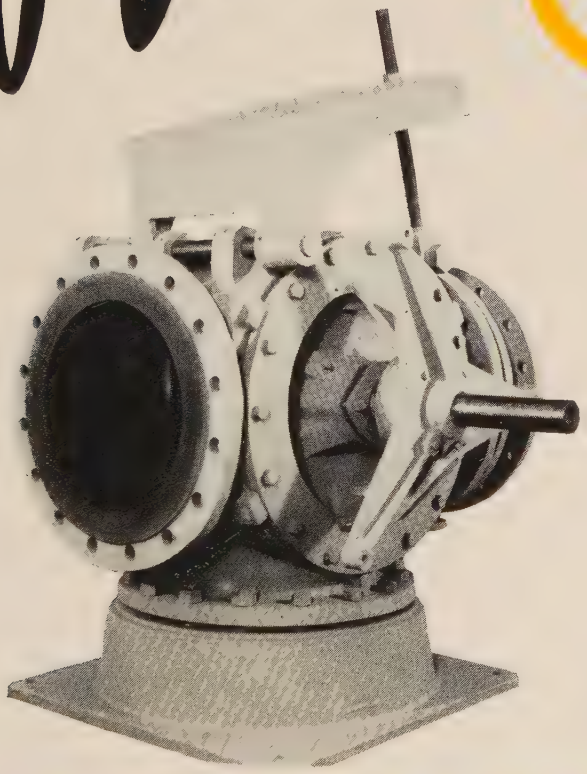

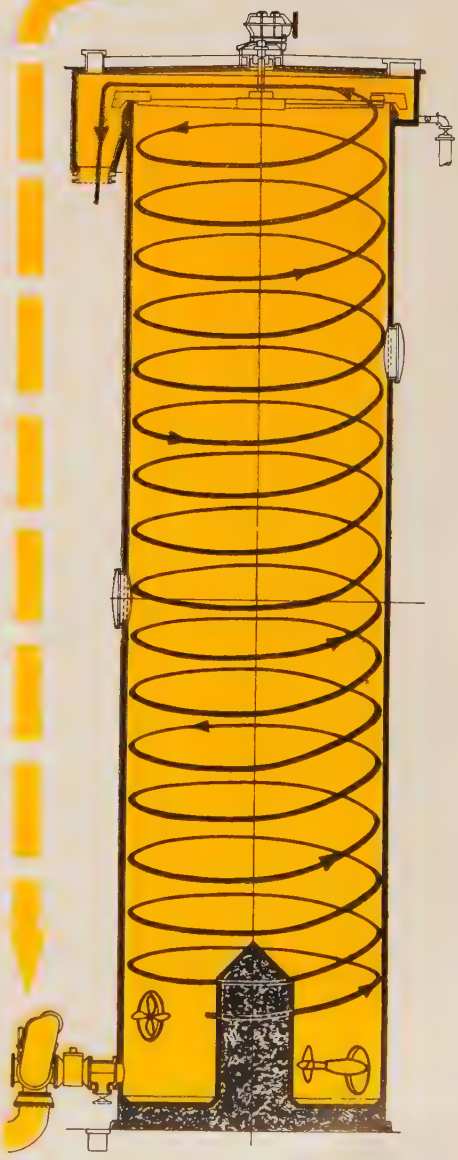

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115 to 121°C. for 2 hr., the total alkali content (as NaOH) of the cooking liquor being 10% on the air-dry weight of bamboo. The second stage of digestion is carried out with 18% alkali at 148°C. for about 3 hr. The cooking liquor contains sodium hydroxide and sodium sulphide in the proportion of 2:1, or sometimes 3:1.

For the production of bleachable pulps by the "overhead" (one-stage) method, digestion is carried out with 20 to 22% of chemicals ($NaOH:Na_2S$ = 2:1) on the air-dry weight of the raw material at 162°C. for 6 hr. Unbleached pulp for wrapping paper is produced by this method using about 15% of chemicals at 142 to 153°C. for 5 to 6 hr.

Bleaching is conducted in a single stage using bleaching powder. Bleach consumption amounts to about 8% of standard bleaching powder (containing 35% available chlorine)and the yields of unbleached and bleached pulps are about 43 and 40% respectively. When the unbleached pulp is made for wrapping papers, the yield is about 50%.

The bleached pulps have a tendency to lose brightness in storage. Brightness stability can be improved, however, by bleaching the pulp in three stages with an intermediate treatment with hot alkali. It has been found that best results are obtained by using about 75% of the total bleach demand in the first stage and the remainder in the second stage. The partially bleached pulp after the first stage is treated with 2% caustic soda at 70°C. for 1 hr.

In all probability modern multistage bleaching methods using chlorine, caustic soda, and hypochlorite, would produce high brightness with good color stability.

Sulphite Process. This process is used by only one mill in India. The cooking liquor contains 4.5 to 5.2% of free SO_2 and 1.2 to 1.4% of combined SO_2 (as magnesium bisulphite). The digestion period is about 10 to 12 hr. The pulp is bleached by a multistage process using elemental chlorine, caustic soda, and bleaching powder.

Products[35]

Bamboo pulps possess all the good qualities of grass pulps and, in addition, are long-fibered. Hence, high quality papers can be made from them. Bleached papers are characterized by high brightness and excellent formation.

High quality wrapping and multiwall sack papers are made from the unbleached sulphate pulps.

For the production of writing and printing papers, bond papers, and bristol boards, both bleached sulphate and sulphite pulps are used.

Bamboo pulps are also used in blends with sabai grass pulp or wood pulp for the production of writing and printing papers. They may also be considered as satisfactory for use as the long fiber component in blends with short-fibered pulps.

Recommendations

1. Far more consideration should be given to bamboo as a source of chemical pulp.

2. As the matter stands today the sulphate process is recommended for the pulping of bamboo. The "fractional" or two-stage method of digestion is to be preferred for the production of easy bleaching pulps, whereas the "overhead" or one-stage method is recommended for unbleached pulps for wrapping papers.

3. Any project should be thoroughly examined by qualified specialists in order to avoid technical failure or an underestimate of investment.

4. With the difficulties inherent in establishing any new industry—particularly one as specialized as pulp and paper—in underdeveloped tropical countries, consideration of new or secret processes only involves unnecessary additional risk and should be avoided.

[35] For detailed table showing possible uses of bamboo pulps see Chapter IV (Table IX).

Conclusions

As bamboo is found mainly in underdeveloped tropical countries, it is essential that a thorough survey of local conditions, raw material supply and investment costs be made before any decision is reached concerning a new project.

While a 30-ton daily capacity plant is usually considered to be of economic size in India, this need not necessarily apply in other countries.

Because of its fiber length and excellent papermaking characteristics, bamboo is especially suitable for the manufacture of wrapping, writing, and printing papers. Bamboo pulps may be used to replace some coniferous wood pulps. It is also possible to blend them with poor types of pulp to make reasonable grades of board and other paper.

VII. GENERAL CONCLUSIONS AND RECOMMENDATIONS

There is present need for increased supplies of pulp and paper throughout the world to keep pace with increasing demand. If the task of industrialization and general economic and social betterment is to be accomplished for the underdeveloped portions of the world, its accomplishment rests is no small degree on availability of pulp and paper products to these regions. Since there is a projected probable rise of 5% per annum in world requirements of pulp and paper over the next decade, it appears highly improbable that such increased demand can be met with existing facilities for production.

It appears, therefore, that the vitally necessary program for increasing the availability of pulp and paper to underdeveloped countries could be well implemented through the use of those resources of the tropics capable of producing pulp and paper insofar as such use is technically and economically feasible.

Such resources exist in very large amounts; broadleaved forests, fiber yielding plants, and agricultural residues in combined tonnages of stupendous proportions. Their mere existence, however, proves little except that, for a complex of reasons, exploitation has not yet proved profitable.

It has been abundantly shown that: (1) technical processes are available for the manufacture of pulp and paper from tropical woods and fiber yielding plants; (2) there is sufficient economic promise in such manufacture to warrant thorough examination and planning of numerous proposals for new pulp and paper producing units in the tropics.

Certain important characteristics of proposed developments distinguish them sharply from their prototypes in the temperate zone. For example, more consideration should be given to production of papers from mixed types of pulps than has usually been the case in northern countries. There is a considerable number of pulps from annual and perennial plants that can be produced in the tropics, and their combination with pulps from tropical species of broadleaved trees could give rise to a broad array of useful papers.

A major obstacle of the immediate establishment of some production units is undoubtedly the unavailability of pulp and papermaking chemicals and facilities in tropical countries and high costs of transportation to points of production. Such obstacles may be overcome in many instances by the balancing effect of lower wood and labor costs, giving a net favorable result.

Such factors cannot be evaluated except through the most careful analysis and planning preceding the final decision on whether to start plant erection or not.

Production of pulp and paper is a part of the general process of industrialization which it is hoped can be achieved in the tropics. Just as the availability of paper may be expected to accelerate industrialization, so this in turn will eventually increase supplies of chemicals and equipment for pulp and papermaking. Paper will cost less and the whole movement will be given further impetus. As this interaction proceeds,

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perhaps slowly for quite a while, experience in manufacturing needed products from tropical woods and wastes may be expected also to increase production and demand.

At some time in the process of industrialization, urban and other requirements for wood will begin to put heavy and increasing demands on the forest. Therefore, in preliminary planning and long-range planning of projects, it is well to invisage integrated operations such as now exist quite widely in the northern hemisphere. Timbers for construction, veneer logs for exports or domestic uses, woods unsuited for paper but perhaps suited for building board manufacture; all these may offer future promise of more profitable forestry operations and closer utilization of the forest crop on a sustained yield basis.

An important general objective in planning for the use of wood, fibrous plants, or wastes for pulp and paper should be the attainment of the highest economic use of the material. It is recognized that this is necessarily a long-term point of view and may be impossible to accomplish in the early stages of development.

In the initial stages of endeavoring to locate new pulp and paper developments in the tropics, it appears advisable that attention should be centered primarily on a few locations that are considered most favorably situated. If operations tend to be overambitious, too widespread and diversified, there may be discouraging failures and the entire program will suffer. Each case should be examined on its own merits and the drawing of economic conclusions from general cost data avoided.

Processes are available; some are already in use in relatively small production units operating on wood and several nonwood materials. Enough is known to assess the future possibilities intelligently, and these are important and promising. But, a vast amount of silvicultural research remains to be done in order to insure the perpetuation of the basic resource. Likewise, there are literally thousands of species of trees, combinations of species and processes using mixed pulps that must have adequate scientific and engineering evaluation before they are ready for industrial use.

The development of a pulp and paper industry in the tropics can take place, but its growth must be parallel to a broadly intensified and accelerated program of research.

There is every reason to expect that, given properly executed technical and economic plans, these large unexploited resources can make a vital contribution to living in what are at present underdeveloped countries. There must be a period of trial, a period of grouping, patient capital, but if the means available are wisely used, there can arise a pulp and paper industry in the tropics that will be of world importance.

The views expressed in this publication represent the opinions of the specialists who attended the consultation.

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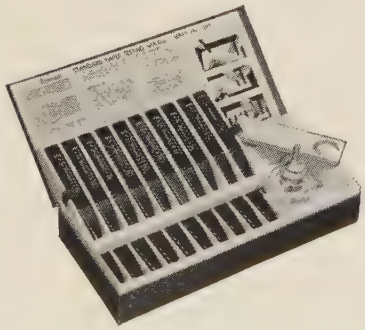

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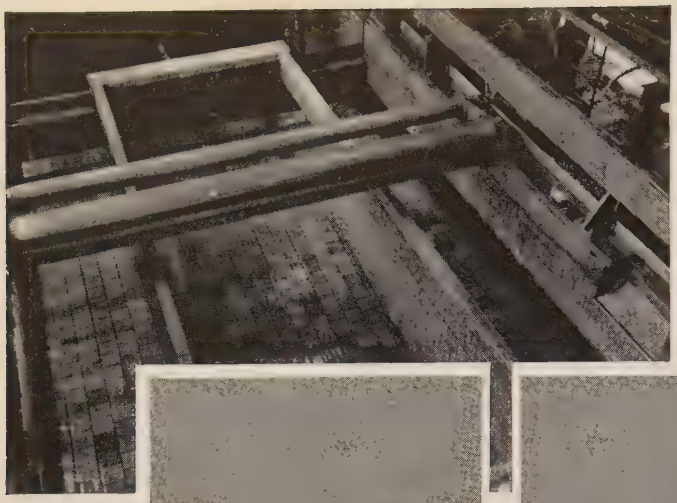

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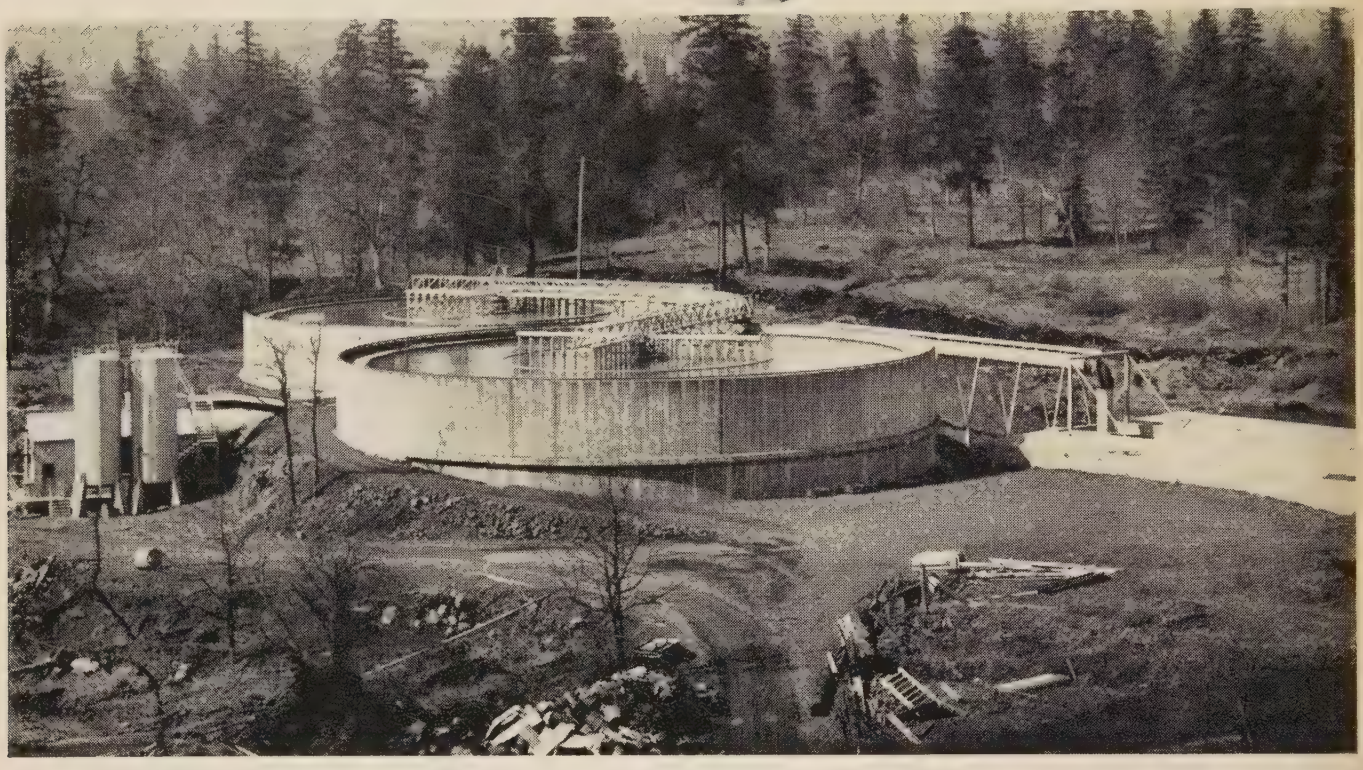

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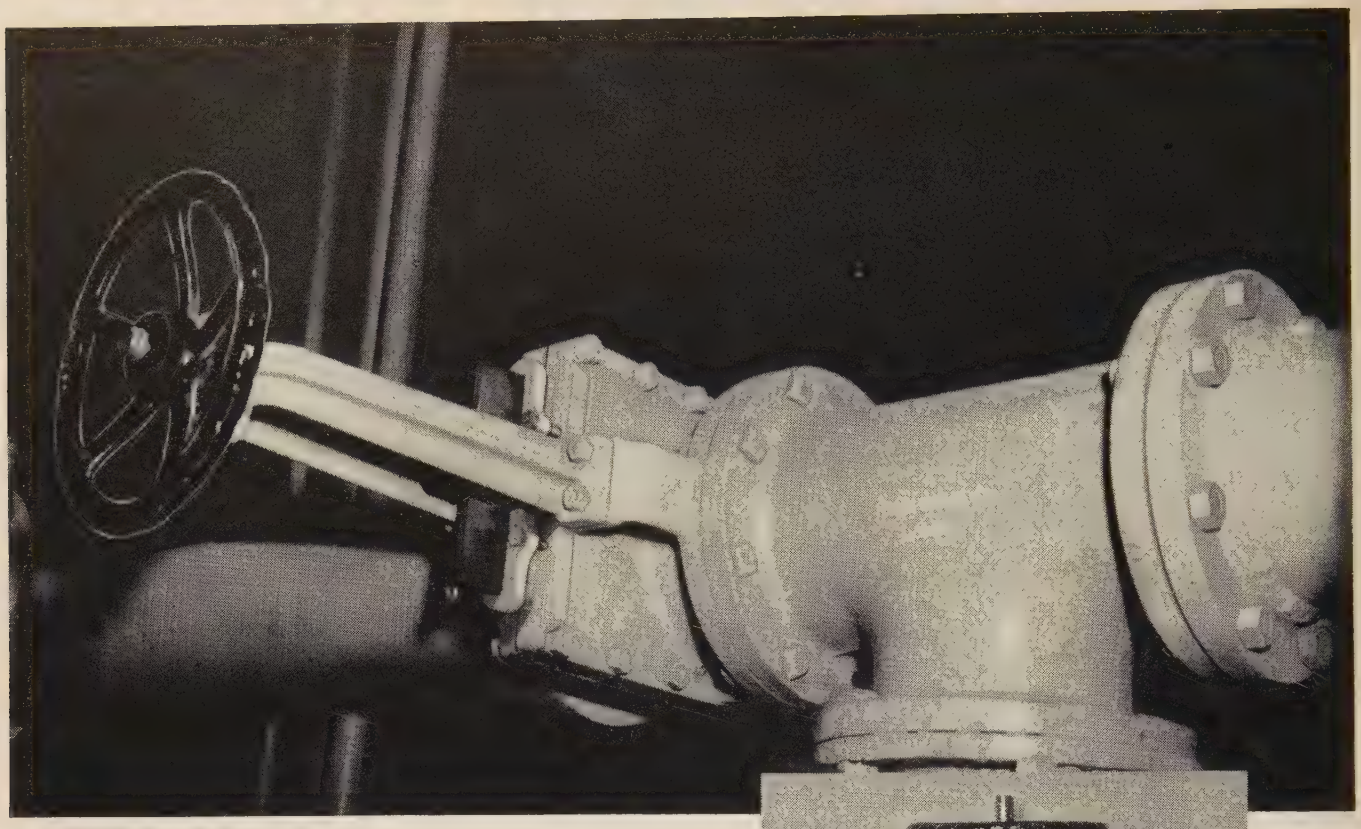

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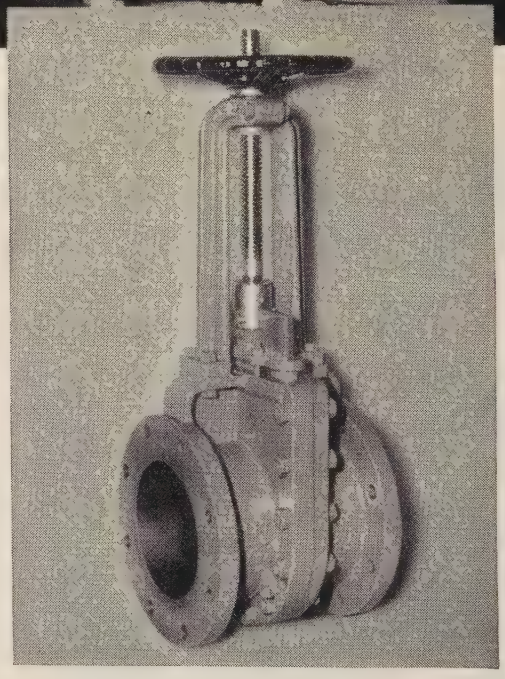

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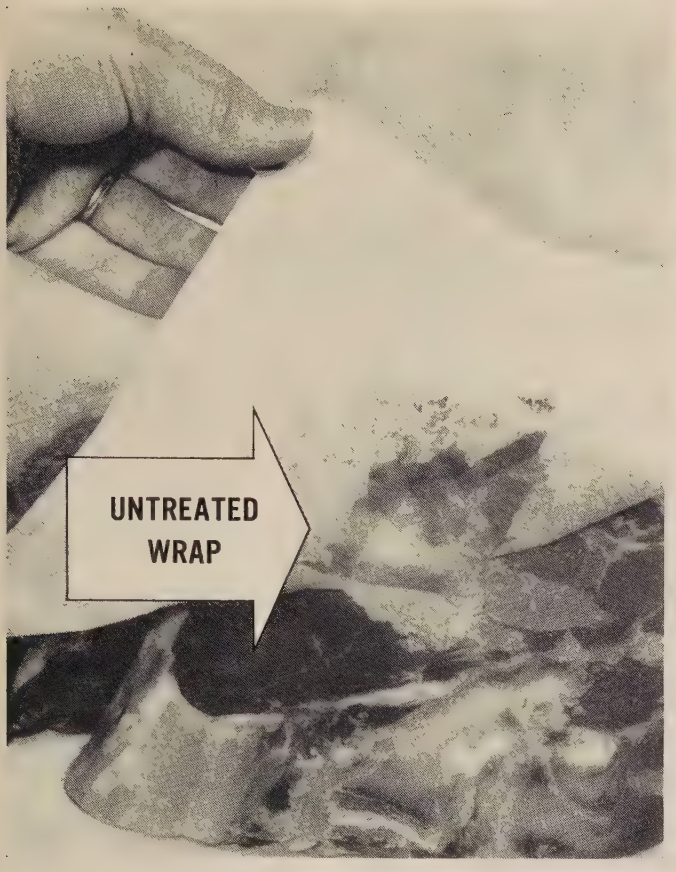

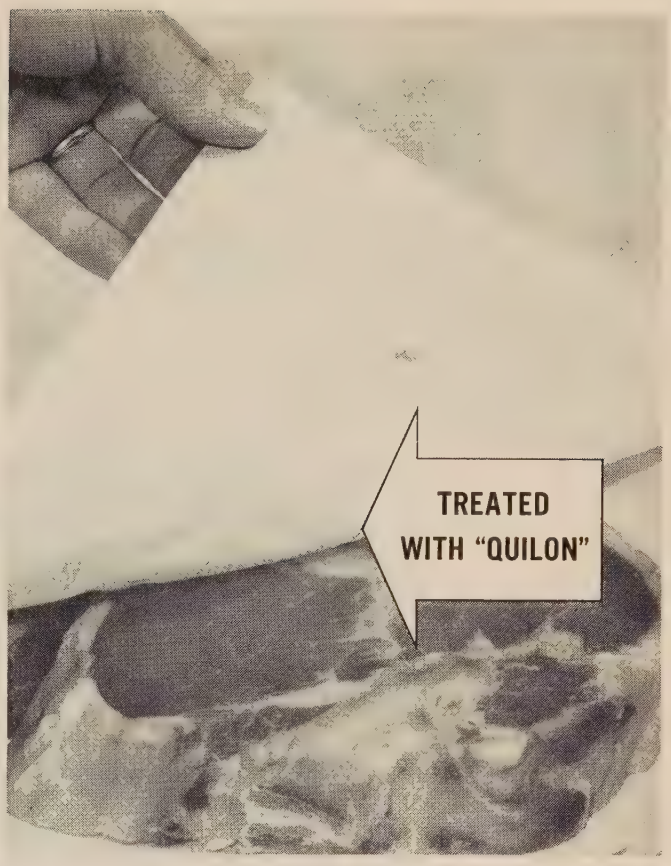

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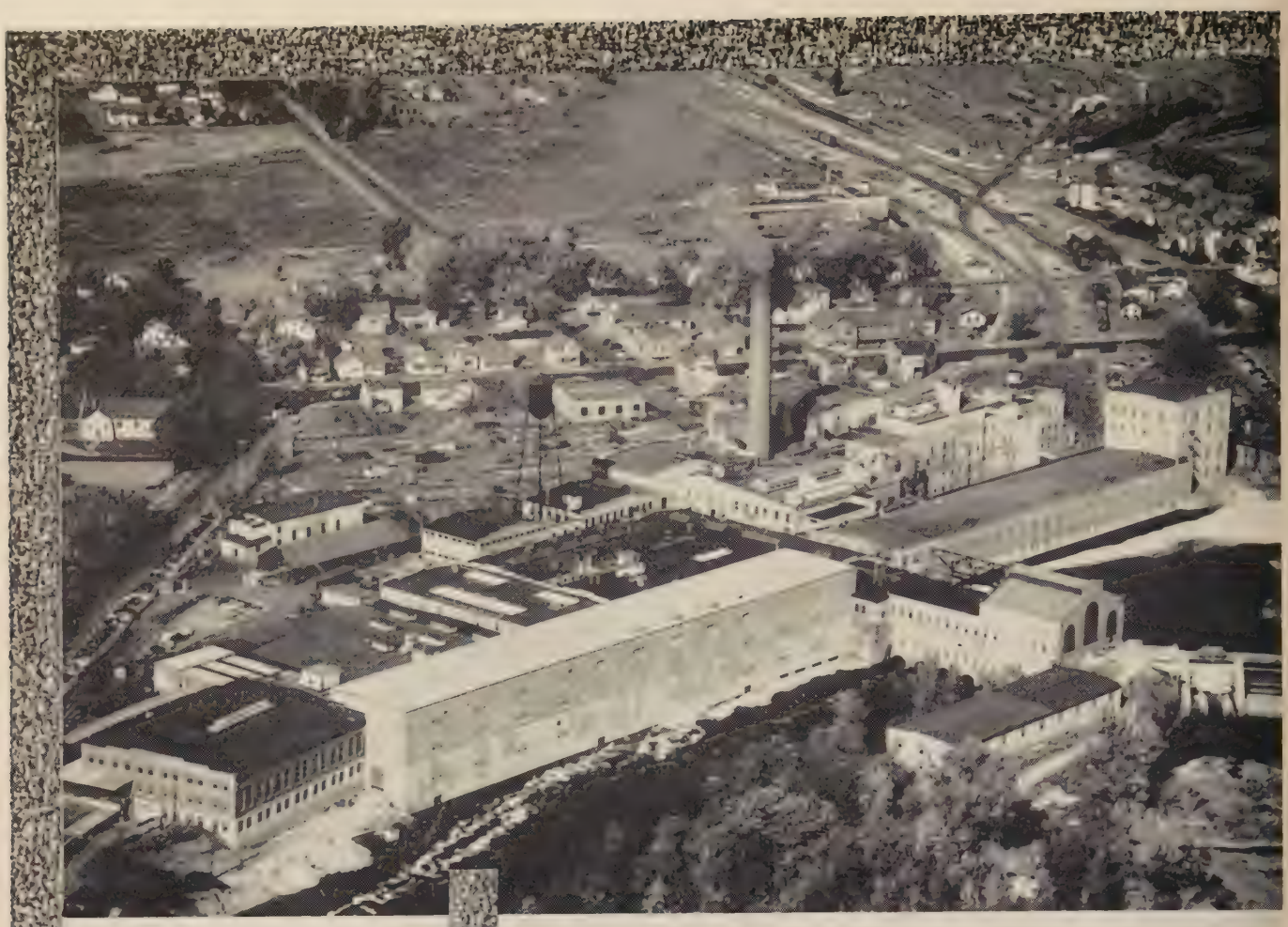

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This time it's another C-E Recovery Unit, the second to be ordered for the Nekoosa, Wisconsin, plant of the Nekoosa-Edwards Paper Company. To help meet the growing demands of expanding sulphate operations, this new C-E Recovery Unit has been designed to burn 1,050,000 lbs of dry solids per 24 hrs, and produce steam at a pressure of 500 psi and at a temperature of 700 F.

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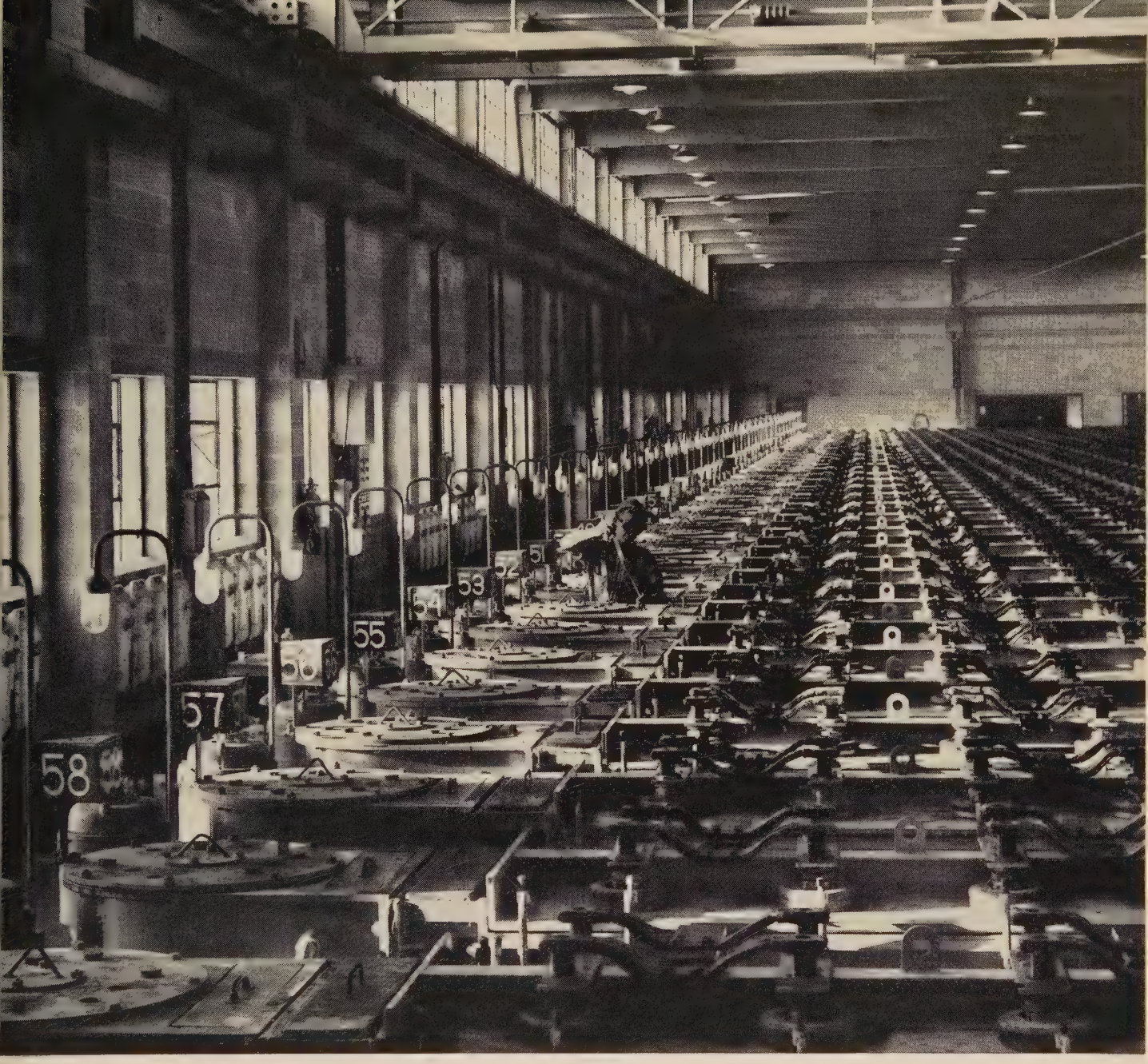

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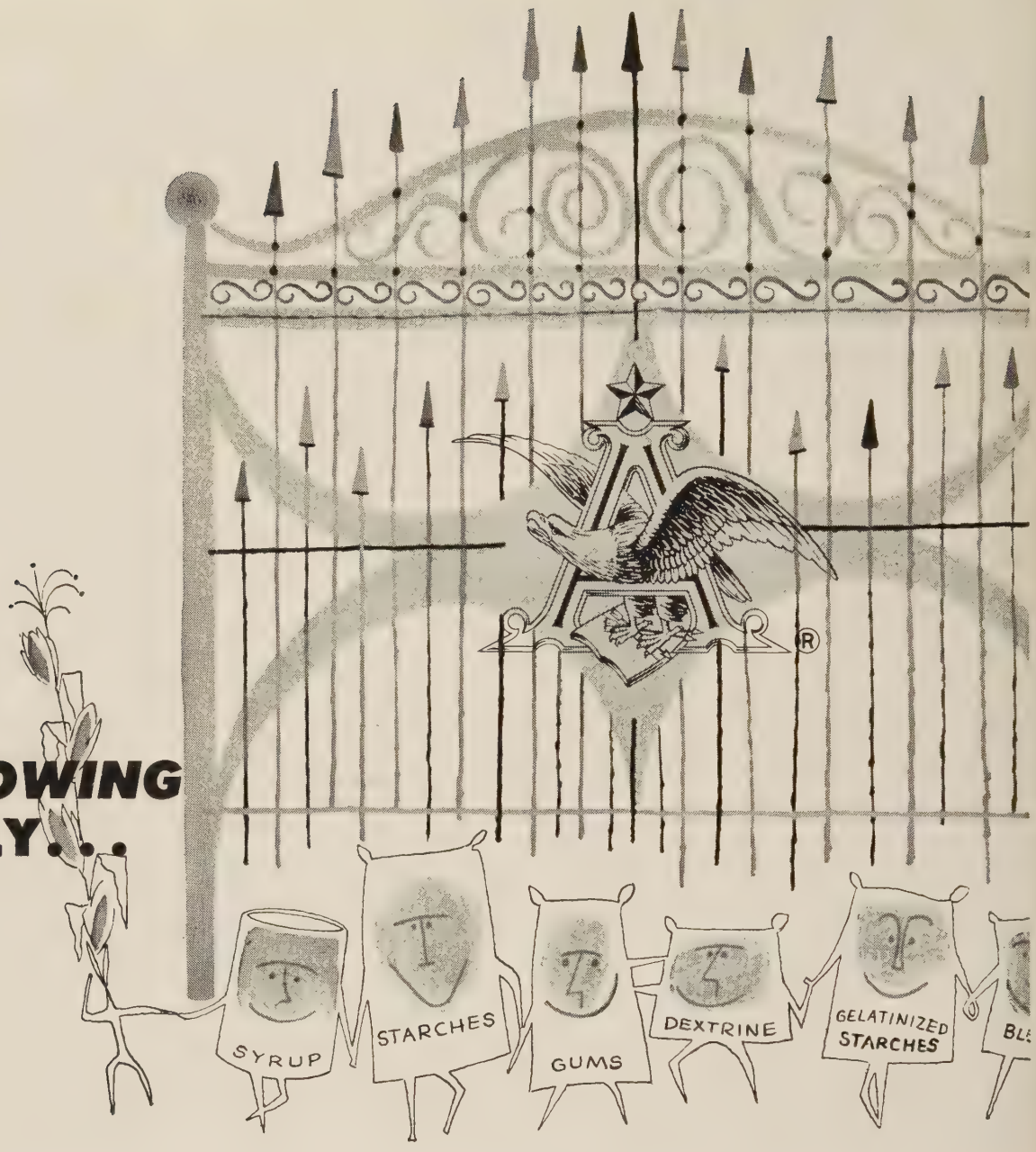

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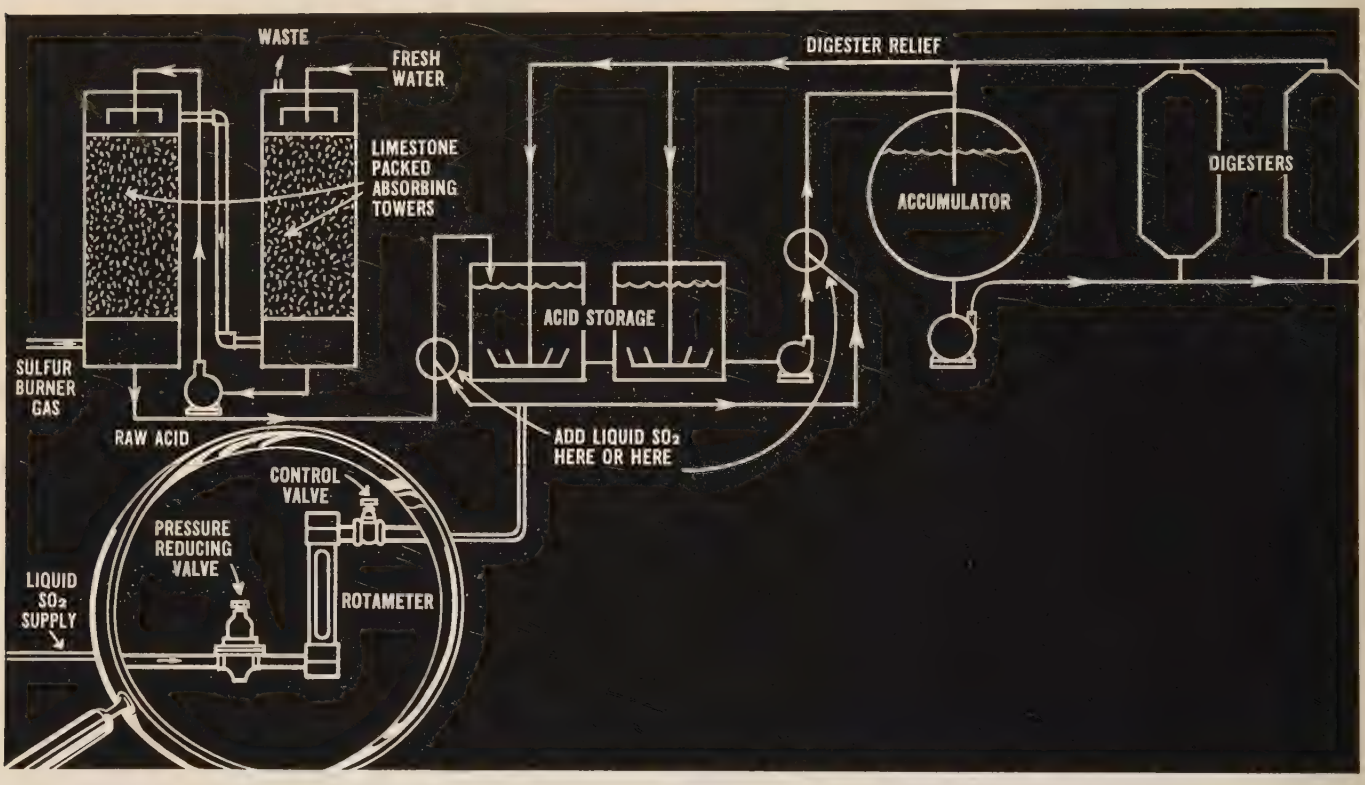

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Installing an Ansul sulfur dioxide system is the sure, economical way to cut cooking time and keep sulfite pulp production going at an even rate *in spite of* wet or green wood cooks, high water temperatures or other hard-to-control variables.

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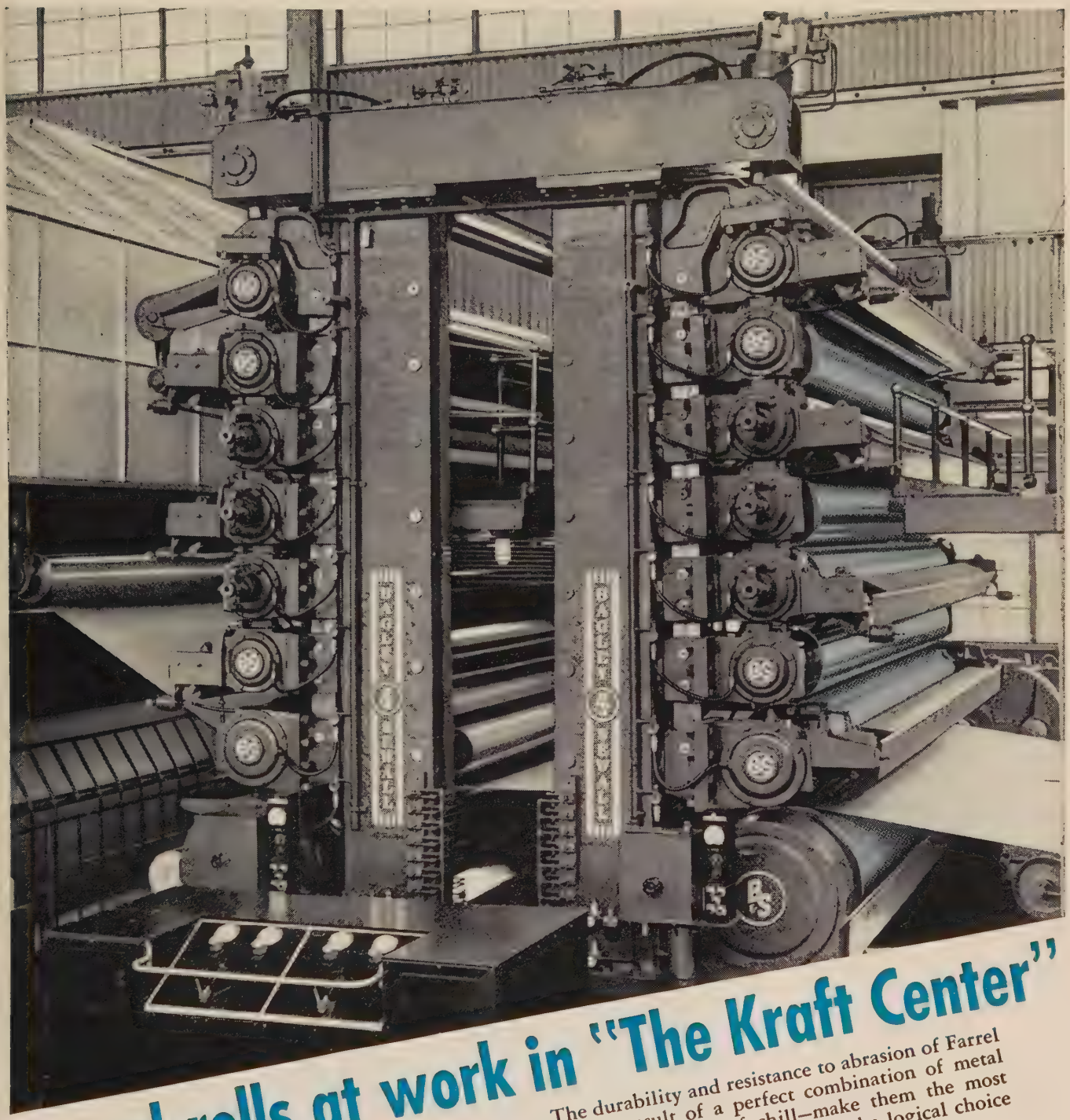

Farrel rolls at work in "The Kraft Center"

St. Regis Paper Company's big kraft operation at Pensacola, Florida, is known as "The Kraft Center." Two mills, complete from pulp-making facilities to fourdriniers, and a large multiwall paper bag plant, inspired the name.

Shown above are two Bagley & Sewall calenders, each equipped with eight precision-ground Farrel rolls. Here at "The Kraft Center," as in most leading paper mills, calender rolls from *roll headquarters* at Ansonia are at work contributing to uniform quality production.

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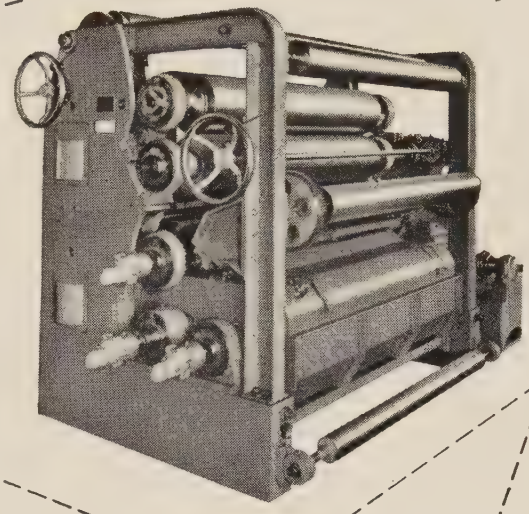
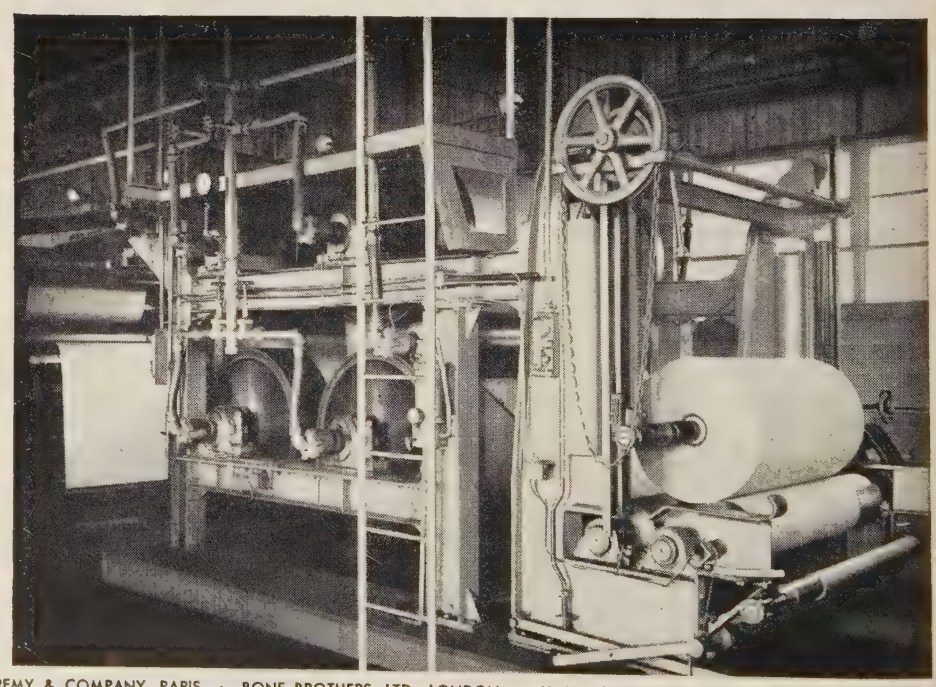


Asphalt Laminator

An Egan installation in the plant of The **CAMP MANUFACTURING COMPANY** producing kraft laminated with asphalt for multiwall bags.

This Egan designed installation laminates two webs of kraft with asphalt at web speeds averaging 950 feet per minute. Incorporates Egan built double shell cooling rolls.

Asphalt Laminator at
CAMP MANUFACTURING COMPANY
showing cooling rolls and double drum winder.



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Flow
mercury-manometer type
"d/p Cell", force-balance transmitter type
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relative humidity (hygroscopic type)
absolute humidity and dew point temperature ("Dewcel")

Liquid Level or Interface (in open or pressured vessels)
diaphragm type
bubble tube (purge) type
differential pressure type

*Load, Force, and Torque

*Moisture Content (sheeted materials)

Motion and Position Recorders

*Motor Load (Power)

Operation Time Recorders

*Oxidation—Reduction Potential

*pH (with Beckman glass electrodes)

Pressure, Absolute Pressure, and Vacuum
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differential type
*electric pressure cell types

*Resistance (Electric)

*Speed (R.P.M. or Lineal)

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*Tension

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Proportional with Reset ("Stabilog")
Proportional with Reset and Derivative ("Hyper-Reset")
Consotrol (Console/Graphic Panel Types): in all above control mechanisms except on-off
Model 41: On-Off and Proportional
Circular Case: On-Off and Proportional

Electric
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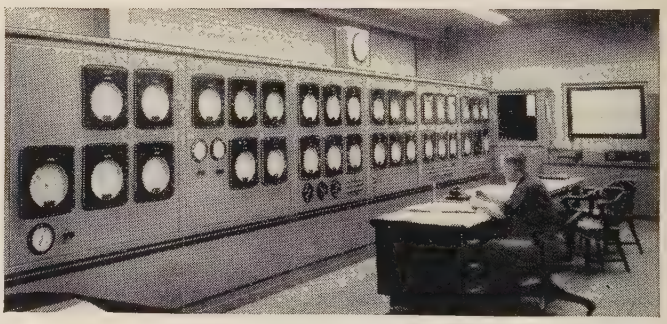
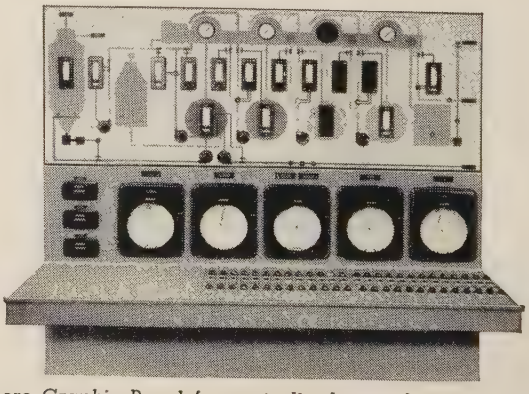
On-Off
Multi-Position
Galvanometer Type
On-Off
2- and 3-position
Proportioning

CONTROL SYSTEMS

Auto-Selector
Averaging
Dual
Duplex
Limit
Ratio
Relation
Sequence
Time Schedule (cam and camless types)



Complete Washer and Bleach Control Panel by Foxboro at S. D. Warren Company, Cumberland Mills, Maine.



Foxboro Graphic Panel for centralized control of brown stock washing at Gaylord Container Corp., Bogalusa, La.

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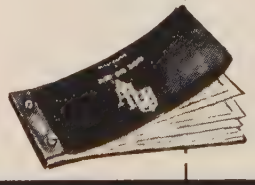
The goal: MORE TONS PER DAY.

Charles W. Page

Mr. Page services paper mills located in states from Indiana to New York. Prior to joining the sales engineering staff of the Albany Felt Company, he was associated with Textron, Inc. of Nashua, New Hampshire. He studied industrial engineering at Cornell University and served over four years in the Army Corps of Engineers.



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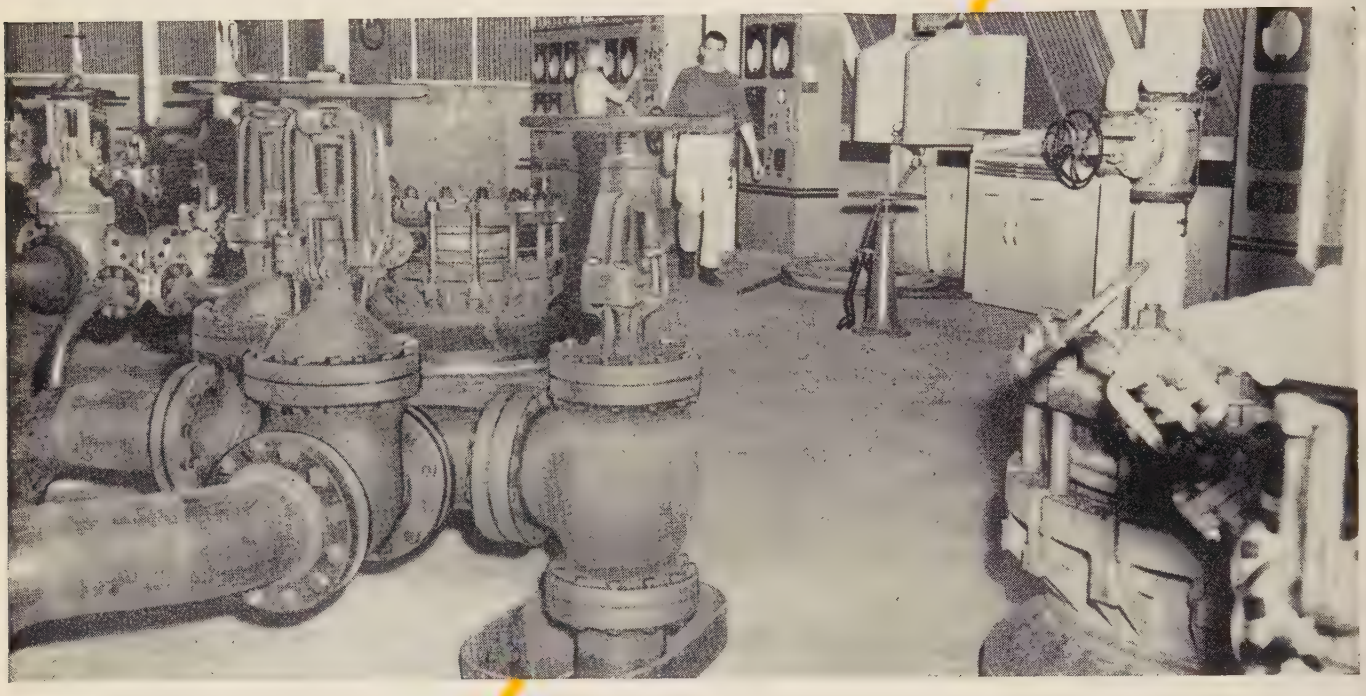
Weyerhaeuser Timber Company, Everett, Washington. The snakelike aluminum covered tube running through the center of the picture is a chip conveyor between a Weyerhaeuser sawmill and the main Kraft mill.

Oh, I see



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The Resistance of Douglas-Fir to Sulphite Pulping

WILLIAM H. HOGE

The precipitate which is formed in calcium-base cooks of Douglas-fir was found to be primarily anhydrous calcium sulphate with small amounts of free sulphur. The sulphate and free sulphur were products of bisulphite decomposition. Analytical methods for determining bisulphite decomposition products were developed. Dihydroquercetin, a phenolic compound in Douglas-fir, reduced bisulphite to thiosulphate which promoted bisulphite decomposition in an autocatalytic, first-order reaction. The wood in the early portion of a sulphite cook reduced the concentration of thiosulphate catalyst and thereby retarded the decomposition of the liquor. Dihydroquercetin was found to be a mild pulping inhibitor but there was no evidence of the formation of an insoluble lignin-inhibitor complex in cooks of Douglas-fir or of spruce impregnated with this compound. Douglas-fir lignin was sulphonated in a conventional sulphite cook. The difficulty in the sulphite pulping of Douglas-fir is attributed to the slow rate of lignin removal which allows the bisulphite decomposition reactions to form large amounts of sulphuric acid before delignification is completed. The sulphuric acid precipitates the base as calcium sulphate and introduces the dangers which accompany the removal of the base. The major advantage of soluble-base liquors is the extended availability of the base for the pulping reaction.

It is generally known that Douglas-fir (*Pseudotsuga taxifolia*) is difficult to pulp in a conventional calcium-base sulphite cook and the pulping resistance of this species has been attributed to a number of different factors.

Wells and Rue (*1*) concluded that Douglas-fir is difficult to pulp due to the pitchy nature of the wood. Beuschlein (*2*) found that the pulping resistance could not be removed by alcohol-benzene extraction and therefore, could not be attributed to pitch or other resinous material. Beuschlein suggested that the difficulty might be the result of physical or chemical characteristics of the lignin. Bailey (*3*) concluded that the lignins in Douglas-fir and spruce have different chemical structures; Brookbank and Brauns (*4*) found no significant difference.

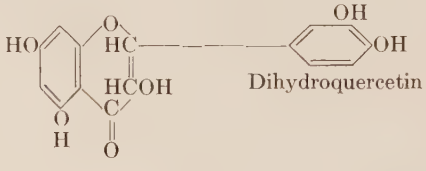
Chidester and McGovern (*5*) and Pew (*6*) studied the penetration of sulphite cooking liquor into Douglas-fir chips. Both reports concluded that, although Douglas-fir is penetrated more slowly than spruce or western hemlock, the wood can be completely penetrated by slightly extending the penetration portion of the cooking cycle.

Brookbank (*7*), Chidester and McGovern (*8*), and Hatch and Holzer (*9*) reported the formation of a precipitate near the end of calcium-base cooks of Douglas-fir, making it necessary to blow the charge quickly to prevent burning. Brookbank described the precipitate as a mixture of calcium sulphate and calcium sulphite, but presented no analytical data. The precipitate is not formed in soluble-base cooks.

Douglas-fir can be pulped by the sulphite process under certain conditions. Chidester and McGovern (*8*) found that the pulping of Douglas-fir can be greatly facilitated by the use of soluble-base liquors; they used longer cooking times with the soluble-base cooks. Brookbank (*7*), Chidester and McGovern (*5*), and Bialkowsky (*10*) have found that the calcium-base pulping of Douglas-fir can be accomplished by the use of high values of free sulphur dioxide (6 to 8%) in the cooking liquor.

Erdtman (*11–13*) showed that polyphenols, particularly those with hydroxyl groups in a 1 to 3 configuration, are strong inhibitors of sulphite pulping. He reported that the inhibitors condense with the lignin in the wood to form an insoluble phenolized lignin product in a reaction which competes with the initial sulphonation. After phenolization has occurred, "only sugar and easily hydrolyzable polysaccharides are removed during the cooking process, leaving cellulose and phenol lignin undissolved" (*12*).

The first indication that a phenolic inhibitor might be present in Douglas-fir came from the work of Pew (*6*) who isolated dihydroquercetin from the heartwood. This compound has also been referred to as Douglas-fir flavanone and taxifolin. Pew analyzed several samples of Douglas-fir and found the average concentration of dihydroquercetin to be about 1%, although one of the samples contained 2.2%. He concluded that this compound is a stronger inhibitor than catechol, but weaker than catechin, resorcinol, or phloroglucinol. Pew briefly studied the pulping of Douglas-fir and concluded that, although dihydroquercetin contributes to the pulping resistance, other factors are also involved. In contrast, Erdtman (*11*) stated that the pulping resistance of Douglas-fir is caused by dihydroquercetin.



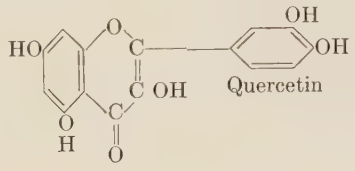
Dihydroquercetin

There are several reasons to believe that the sulphite pulping resistance of Douglas-fir cannot be explained by the theory of phenolic inhibitors. The pulping resistance is reportedly dependent on the base used in the cooking liquor. The formation of a precipitate in the cooking liquor is difficult to explain by the phenolization theory. Migita and co-workers (*14*) cooked dihydroquercetin in the presence of isolated native lignin and found that very little condensation occurred. Also, Adler and Stockman (*15*) found that pretreatment with formaldehyde allowed the successful sulphite pulping of woods containing established phenolic

William H. Hoge, Graduate Student, The Institute of Paper Chemistry, Appleton, Wis.; present address, Oxford Paper Co., Rumford, Me.

inhibitors, but, in contrast, the treatment had no effect on Douglas-fir.

The first indication that the dihydroquercetin in Douglas-fir might act in some other manner came from the work of Kurth and Chan (*16*), who found that dihydroquercetin is oxidized to quercetin in bisulphite solutions. Kurth (*17*) concluded that bisulphite



Quercetin

solutions do not lose their ability to oxidize successive batches of dihydroquercetin. The reduction product was not identified, but other oxidations in acidic sulphite liquors are usually accompanied by the reduction of bisulphite to thiosulphate. The possible formation of thiosulphate suggested that the precipitate formation in Douglas-fir sulphite cooks might be the result of thiosulphate-catalyzed bisulphite decomposition.

Foerster and co-workers (*18*) showed that thiosulphate is a catalyst in the following over-all bisulphite decomposition reaction:

$$4HSO_3^- \rightarrow 2SO_4^= + S_2O_3^= + 2H^+ + H_2O$$

The intermediate steps in the decomposition consist of the formation of polythionates and their reaction with bisulphite to form sulphate and thiosulphate.

Any compound which causes the formation of thiosulphate in sulphite cooking liquor is a potential promoter of bisulphite decomposition. Free sulphur promotes decomposition (*18–20*), presumably through its direct combination with bisulphite to form thiosulphate. Certain wood compounds are dehydrogenated in sulphite cooking liquor and reduce bisulphite to thiosulphate according to the following reaction:

$$4[H] + 2HSO_3^- \rightarrow S_2O_3^= + 3H_2O$$

Terpenes (*21*), sugars (*22–24*), and formic acid (*25*) react in this manner.

EXPERIMENTAL WORK

Methods Used

TAPPI procedures were used in this program except where noted.

A method was developed for the determination of sulphite, sulphate, thiosulphate, and polythionates in partially decomposed sulphite cooking liquors. The procedure was largely based on the methods proposed by Kurtenacker (*26*). Sulphate was determined as barium sulphate after blocking the sulphite with formaldehyde and oxidizing the thiosulphate to tetrathionate. The concentrations of sulphite, thiosulphate, and trithionate were determined in the neutralized solutions and these results were used to calculate the sulphite, thiosulphate, and polythionates in the acidic liquor. Analytical results on known mixtures showed the method to be accurate to within ±3% of the true value. Also a procedure for the determination of solid mixtures of calcium sulphate, calcium sulphite, and free sulphur was developed and proved to be reliable. The sulphite was determined by direct iodine titration, the combined sulphite and sulphate were precipitated as barium sulphate and the sulphur was determined by reacting it with sulphite and titrating the resultant thiosulphate.

The decomposition of sulphite spent liquors was determined by measuring pH, combined sulphur dioxide, sulphate, and thiosulphate. The combined sulphur dioxide was determined by the Sander method (*27*). Thiosulphate was directly titrated after blocking the sulphite with formaldehyde, as described by Samuelson and Westlin (*28*). Sulphate was determined by precipitating the titrated thiosulphate sample with barium chloride in cool dilute solution.

The soluble lignin in the pulp was calculated from the ultraviolet absorbance of the lignin filtrates from the 72% sulphuric acid method and the absorptivity of spruce native lignin reported by Barton (*29*). This soluble lignin was calculated at wavelengths of 230, 250, 280, and 300 mmu. In each case, the minimum value of soluble lignin was obtained at 230 mmu, and all reported values were calculated at this wavelength. The necessity for the soluble lignin analysis and its inherent weaknesses have been discussed by Browning and Bublitz (*30*).

In several of the sulphite cooks, separate analyses were reported for the liquor expressed from the interiors of the chips and the liquor which was recovered upon draining the digester. The expressed liquor was recovered by masticating the chips in a Banbury mixer, placing the wet pulp in a Buchner funnel covered with a rubber sheet, and applying a vacuum. The vacuum caused the loss of free sulphur dioxide and therefore, direct comparison of the expressed and drained liquors from a single cook cannot be made. The analyses are useful for comparing the relationships between the expressed and drained liquors from different cooks.

The Preparation of Dihydroquercetin

The dihydroquercetin was extracted from a cork-enriched fraction of Douglas-fir bark prepared by an adaptation of the treatment described by Hergert and Kurth (*31*). The final cork product was pre-extracted with benzene, thoroughly air dried, and extracted with ether. The crude ether extract was given three successive treatments with Darco decolorizing carbon and recrystallizations from hot water.

The purified dihydroquercetin was compared with authentic material isolated by Pew (*6*) and a commercial sample from Krishell Laboratories of Portland, Ore. Each sample had a melting point between 240 and 243°C. (dec.), and an $[\alpha]_D^{25}$ of +44 to +47°. Chromatographic comparisons showed that all the samples contained very small amounts of impurities.

The Paper Chromatography of Phenolic Compounds

The primary requirement of a chromatographic system for use in this program was the ability to separate dihydroquercetin from quercetin. After testing several developers, a solution of 0.01 *N* hydrochloric acid was found to be satisfactory. The quercetin was not moved and the dihydroquercetin was concentrated into short streaks at an R_f* of 0.28. The spray reagent was a freshly prepared mixture of 1% solutions

* The R_f factor is the ratio of the distance traveled by the compound to the distance traveled by the total solvent front.

Table I. Wood Analyses

	Spruce	Douglas-fir sample B
Alcohol-benzene solubility, %	2.20	4.66
Hot-water solubility, %	2.72	1.86
Insoluble lignin, %	26.4	28.2
Soluble lignin, %		
Calculated at 230 mmu	0.18	0.16
250 mmu	0.34	0.29
280 mmu	1.43	1.47
300 mmu	1.43	1.51

of ferric chloride and potassium ferricyanide, as proposed by Barton, Evans, and Gardner (*32*). The freshly sprayed chromatograms were fixed by washing in dilute hydrochloric acid and water.

All of the chromatograms prepared by this method had a line like a solvent front across the paper at an R_f value of about 0.7. This line, which became visible after spraying, was the zone of a sharp pH gradient. It was found that the water moved faster than the hydrochloric acid and the line was the location of an acid front.

Five different phenolic compounds were studied with the described developer and spray reagent: quercetin ($R_f = 0$), dihydroquercetin ($R_f = 0.28$), catechin ($R_f = 0.39$), phloroglucinol ($R_f = 0.51$), and resorcinol ($R_f = 0.66$).

Wood Procurement and Analysis

Three different pulpwoods were used in this program. Liquor precipitates were obtained from cooks of Douglas-fir sample A, a 107-year-old, 32-in. diameter tree with a heartwood content of 82%, on a volume basis. Douglas-fir sample B was used in the other pulping experiments. This was a 275-year-old tree with a 29-in. diameter, containing 90% heartwood. The spruce was about 6 in. in diameter and had been barked and seasoned.

All sulphite cooks were made with chips averaging $^1/_2$ in. in the grain direction. The undersized debris was screened out and the oversized pieces were removed manually.

The lignin contents of the spruce and Douglas-fir sample B were determined after successive extractions of the 40 to 60 mesh sawdust with alcohol-benzene (1:2) and hot water. The soluble lignin contents of these samples were calculated at four different wavelengths; the minimum value, obtained at 230 mmu, represents the maximum possible concentration of soluble lignin in the wood. These analyses are shown in Table I.

The insoluble lignin and the extractive contents of these wood samples are in general agreement with results reported by other authors. The soluble lignin content of spruce is in fair agreement with the findings of Browning and Bublitz (*30*), who reported a value of 0.9%, calculated at 280 mmu. The data disagree with the findings of Campbell and McDonald (*33*) and Von Wacek and Shroth (*34*) who reported spruce-soluble lignin values of 5.8 and 5.5%, respectively.

The alcohol-benzene extract of Douglas-fir gave a strong chromatographic test for dihydroquercetin, whereas, the hot water extract appeared to contain none of this material. The failure of hot water, a favorable extractant for dihydroquercetin, to remove this compound indicated that all the dihydroquercetin had been removed from the Douglas-fir by the alcohol-benzene. These results are pertinent to the findings of Beuschlein (*2*) who reported that alcohol-benzene extracted Douglas-fir sawdust was extremely resistant to sulphite pulping.

Other chromatographic studies showed that the alcohol-benzene extract of spruce contained an unidentified compound which appeared at an R_f of 0.64 to 0.70. This same compound was observed in an ethanol extract. Separate tests on ethanol extracts of Douglas-fir sample A showed that dihydroquercetin is present in both the heartwood and the sapwood of this species although the concentration appeared to be greater in the heartwood.

The Precipitates Formed in Douglas-Fir Sulphite Cooks

Three calcium-base sulphite cooks of Douglas-fir sample A were conducted to obtain precipitate samples. The pulping variables were varied between the following limits:

Maximum temperature: 145°C.
Time of cooking: $10^1/_2$ to 12 hr.
Dry weight of chips charged: 97 to 129 grams
Total SO_2 in liquor: 6.10 to 6.75%
Combined SO_2 in liquor: 1.20 to 1.25%
Liquor ratio: $6^1/_2$:1 to 8:1

The light tan precipitate, which had the appearance of a fine beach sand, appeared to be evenly distributed through the digester charge. The material was separated from the fibers by mixing the pulp with water and collecting the precipitate from the bottom of the container. Recovery was not complete. The precipitates were quickly placed in weighing bottles and dried at 80°C. in a nitrogen atmosphere prior to analysis. The precipitate analyses are shown in Table II.

The precipitates were primarily anhydrous calcium sulphate. The amount of free sulphur in the precipitates was small but sublimed sulphur crystals were formed on the sides of the bottle during the drying of one of the precipitates. The predominance of calcium sulphate, along with the definite presence of small amounts of free sulphur, suggested that the precipitates were the result of bisulphite decomposition.

The Decomposition of Sulphite Cooking Liquor

The decomposition of sodium-base sulphite cooking liquor was studied in a series of cooks in the absence of wood. The cooking liquors contained 6.00% total sulphur dioxide and 1.40% combined sulphur dioxide. The temperature was raised to 140°C. in 90 min. and maintained at 140°, without pressure relief, for varying periods of time.

The first group of cooks was conducted with 7 millimoles per liter of thiosulphate in the cooking liquor. The semilogarithmic plots of thiosulphate and sulphate concentrations versus time are shown in Fig. 1.

Table II. Composition of Precipitates

	Cook 1	Cook 2	Cook 3
Precipitate recovered, g.	2.06	1.16	2.40
Sulphate, as $CaSO_4$, %	90.0	91.7	89.4
Sulphite, as $CaSO_3$, %	0.9	1.0	0.8
Free sulphur, %	0.4	0.8	2.1
Loss on ignition, %	5.8	3.7	4.2

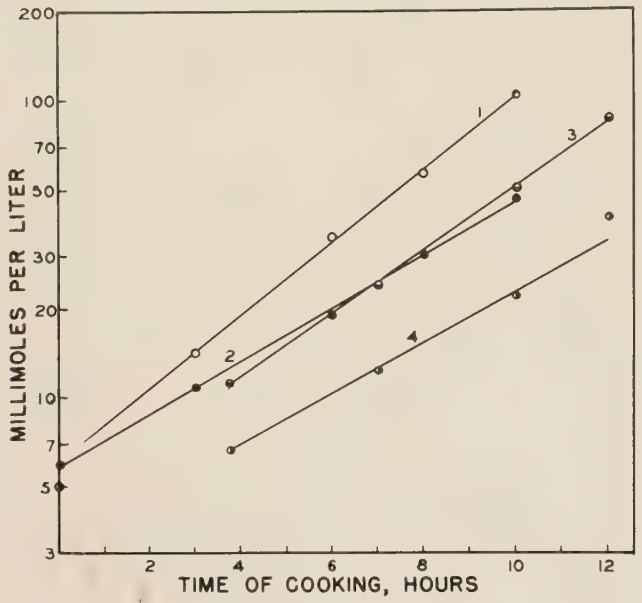


Fig. 1. A semilogarithmic plot of bisulphite decomposition products against time

1—Sulphate from thiosulphate catalyst. 2—Thiosulphate from thiosulphate catalyst. 3—Sulphate from dihydroquercetin catalyst. 4—Thiosulphate from dihydroquercetin catalyst.

The straight line, which shows that the decomposition is a first-order reaction, indicates that the rate of thiosulphate increase is proportional to the thiosulphate concentration. The specific reaction rate, k, calculated from the thiosulphate increase, is 0.21 hr.$^{-1}$.

The second group of cooks was conducted with a dihydroquercetin concentration of 14 millimoles per liter. The additive concentration was doubled because it was expected that 2 moles of dihydroquercetin would be required to form 1 mole of thiosulphate. The curves of thiosulphate and sulphate versus time for dihydroquercetin-catalyzed decomposition are also shown in Fig. 1. The specific reaction rate, calculated from the thiosulphate increase, is 0.20 hr.$^{-1}$.

The quercetin yields from the cooks with dihydroquercetin were between 45 and 50%. The mixture of quercetin products isolated from these cooks was found to be 94% pure, using the method of Naghski and Krewson (*35*), which is based on the measurement of the ultraviolet absorbance at 375 mmu.

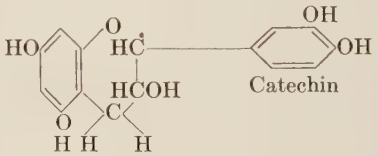
After 10 hr. at 140°C., 23.8% of the total sulphur in the thiosulphate-catalyzed liquor was present as decomposition products. The corresponding value for the dihydroquercetin-catalyzed liquor was 11.1%. According to the equation for a first-order reaction, this indicates that the original thiosulphate concentration was only 46% as great in the cooks with dihydroquercetin. This figure is in agreement with the quercetin yields.

The similarity between the characteristics of bisulphite decomposition catalyzed by thiosulphate and dihydroquercetin indicates that thiosulphate is the catalyst in both cases. The dihydroquercetin probably forms thiosulphate by the reaction:

$$2\ \text{Dihydroquercetin} + 2HSO_3^- \rightarrow 2\ \text{Quercetin} + S_2O_3^{=} + 3H_2O$$

A group of other compounds were tested to determine their effects on sulphite cooking liquor stability. All cooks were continued for 10 hr. at 140°C. The results of these cooks are shown in Table III.

Phloroglucinol, resorcinol, and catechin do not promote bisulphite decomposition. Chromatograms showed that phloroglucinol and resorcinol were unchanged by the cook; catechin was partially changed and formed products with R_f values of 0.66, 0.75, and 0.89. The failure of catechin to reduce bisulphite is interesting in view of its close structural similarity to dihydroquercetin.



The promotion of bisulphite decomposition by sugars illustrates one of the difficulties in the attempt to recycle final sulphite spent liquors back into the digester. The danger of free sulphur in sulphite cooking liquor is also shown by these data.

An additional group of cooks were conducted to determine the effect of temperature on the rate of thiosulphate-catalyzed bisulphite decomposition. The results showed that between 130 and 140°, the rate of reaction is doubled for each temperature increase of 5°C. Above 140°, the temperature effect appears to increase.

Dihydroquercetin and Douglas-Fir Pulping

A series of sulphite cooks were conducted to compare the pulping characteristics of spruce, spruce impregnated with dihydroquercetin, and Douglas-fir. These

Table III. Comparison of Decomposition Catalysts

Cooking liquor: sodium base, 6.00% total SO_2, 1.40% combined SO_2. Temperature schedule: 1½ hr. to 140°, 10 hr. at 140°C.

Additive	*Additive concentration, millimoles/liter*	*Theoretical thiosulphate formed from additive, millimoles per liter*	*Decomposition products, millimoles per liter*			*Sulphur in decomposition products, %*
			Sulphate	*Thiosulphate*	*Polythionate*	
Pure liquor	0.0	..	24.4	9.1	0.1	4.6
Phloroglucinol	14.0	..	25.0	10.7	..[a]	5.4
Resorcinol	14.0	..	20.8	7.6	1.2	4.4
Catechin[b]	14.0	..	22.6	8.2	1.3	4.7
Dihydroquercetin	14.0	7.0	50.3	22.5	2.3	11.1
Formic acid	7.0	3.5	52.3	26.6	0.8	11.7
Free sulphur	7.0	..[c]	51.9	28.5	0.8	12.1
Thiosulphate	7.0	7.0	105	47.7[d]	5.7	23.8[d]
Free sugars[e]	28.0	14.0	97	41.6	10.9	24.7
Formic acid	14.0	7.0	142	45.8	20.0	33.4

[a] The calculated concentration of 8 millimoles per liter could have resulted from interference by phloroglucinol.
[b] This material was optically inactive and had a melting point of 212 to 214°C. Chromatographically, it appeared to be pure. Properties correspond most closely to *dl*-catechin.
[c] The free sulphur was not completely dissolved. This cook is only of qualitative value.
[d] This figure includes the thiosulphate added to the original liquor.
[e] The mixture contained 65% mannose, 25% xylose, and 10% galactose, on a molar basis.

cooks were conducted in a 1-liter digester and all pulp analyses were carried out on samples representing the total yield. The variables in this series of cooks were the type of wood charged, the time of cooking, and the cooking liquor base. The results are shown in Table IV.

The data show that dihydroquercetin acts as a mild pulping inhibitor. Dihydroquercetin caused the lignin content and the permanganate number of the pulp to be increased. Comparative cooks are A and B, C and D, and G and I.

Although dihydroquercetin is a mild pulping inhibitor, its effect is different from that described for phenolic inhibitors. In a cook of spruce impregnated with dihydroquercetin, over half of the lignin remaining in the pulp after 9 hr. of cooking was removed by extending the cooking time $1^1/_2$ hr. (cooks D and I). The trend is similar to that in cooks C and G, without this compound. In Douglas-fir cooks E and F, the additional $1^1/_2$ hr. of cooking removed half of the lignin remaining after 9 hr. Therefore, the effect of dihydroquercetin and the pulping resistance of Douglas-fir cannot be attributed to the formation of an insoluble lignin-inhibitor complex.

The sulphur content of lignins in Douglas-fir pulps indicates that the lignin can be sulphonated. The sulphur in the lignin was calculated from the sulphur content and the total lignin content of the pulp. The errors in the soluble lignin analysis tend to make the results too high and, therefore, the sulphur contents of lignins E, F, J, and K probably are minimum values. A comparison between the sulphur contents in spruce lignins J and K and those in Douglas-fir lignins E and F depends on the uncertain accuracy of the total lignin values. The sulphur contents of lignins E and F appear to show that the Douglas-fir lignin can be satisfactorily sulphonated. Brauns (*36*, *37*) reported that the minimum sulphur content to render lignin soluble is about 3.5%, and, upon additional cooking, lignosulphonic acids with about 6.5% sulphur are formed. The sulphonation of Douglas-fir lignin shows that the pulping resistance cannot be explained by the phenolization theory. Phenolic inhibitors reportedly prevent the satisfactory sulphonation of the lignin.

Although dihydroquercetin is a strong promoter of bisulphite decomposition in the absence of wood, it has little or no effect on decomposition reactions in the presence of wood. The 9-hr. liquors B and D, with dihydroquercetin, had approximately the same amount of decomposition as liquors A and C. The $10^1/_2$-hr. liquor I was more decomposed than liquor G, but the difference was small and its effect on the pulping reactions was probably of minor consequence.

A major portion of the dihydroquercetin in a sulphite cook reacts with bisulphite to form quercetin and thiosulphate. The thiosulphate appears to have little or no effect on the pulping characteristics, and therefore it would be expected that quercetin contributes to pulping resistance. The comparison of cooks L and C shows that quercetin is a mild pulping inhibitor.

The base precipitation was observed not only in Douglas-fir cook F, but also in spruce cooks G and I. This showed that the precipitation is a normal consequence of liquor decomposition and is not due to a peculiar characteristic of Douglas-fir.

There was no evidence of quercetin or calcium sulphate blocking diffusion in the pores of the chips in these cooks. The differences between the expressed and drained liquors were approximately the same for cooks of spruce, spruce impregnated with dihydroquercetin, and Douglas-fir.

The difficulty in Douglas-fir pulping appears to be the slow rate of lignin removal. This allows the bisulphite decomposition, which proceeds at a normal

Table IV. Comparative Pulping Data

Cooking liquor: 1.25% combined SO_2, 5.00% total SO_2. Liquor ratio: 6 to 1. Temperature schedule: 1 hr. to 90°, 3 hr. from 90 to 115°, 2 hr. from 115 to 140°, remainder of cook at 140°C. Maximum pressure: 75 p.s.i.

	Cook										
	A	*B*	*C*	*D*	*E*	*F*	*G*	*I*	*J*	*K*	*L*
Wood pulped	Spruce	Spruce	Spruce	Spruce	D.-Fir	D.-Fir	Spruce	Spruce	Spruce	Spruce	Spruce
Additive	None	3.4% DHQ[a]	None	3.2% DHQ[a]	None	None	None	3.3% DHQ[a]	None	None	2.1% Quercetin
Cooking liquor base	Na	Na	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca	Ca
Total cooking time, hr.	9	9	9	9	9	$10^1/_2$	$10^1/_2$	$10^1/_2$	$6^1/_2$	$7^1/_2$	9
Drained liquor											
pH	1.53	1.49	1.40	1.38	1.38	1.39	1.19	1.19	1.63	1.52	1.48
Sulphate, mmol./l.	28.8	25.9	8.9	10.2	10.3	35.9	33.5	44.4	9.5	9.1	10.1
Thiosulphate, mmol./l.	15.0	19.4	14.3	18.2	16.8	14.8	28.4	25.6	7.1	10.9	20.5
Combined SO_2, %	0.56	0.64	0.47	0.47	0.46	−0.07	−0.09	−0.17	0.66	0.55	0.44
Free SO_2, %	2.72	2.64	1.93	2.23	2.46	1.38	1.40	1.01	2.42	2.36	2.07
Expressed liquor											
pH	4.00	3.92	3.70	3.67	4.35	1.73	1.51	...	...	...	...
Sulphate, mmol./l.	33.6	30.8	27.9	31.2	25.4	49.5	48.3	...	...	...	...
Thiosulphate, mmol./l.	18.0	21.6	18.4	22.8	22.0	12.9	21.8	...	...	...	...
Combined SO_2, %	0.42	0.50	0.39	0.39	0.43	−0.09	−0.05	...	...	...	...
Pulp											
Total yield, %	49.9	51.1	50.1	50.5	59.0	50.1	44.0	46.1	65.7	57.2	51.4
Permanganate number	15.0	26.6	17.7	40.9	>45	38.0	5.2	14.8	45	32.5	36.2
Alcohol solubility, %	1.75	1.73	1.55	1.51	0.78	1.11	0.89	1.09	1.34	1.09	1.04
Insoluble lignin, %	1.2	4.1	2.2	7.0	14.8	8.3	0.3	1.8	13.1	6.3	4.3
Soluble lignin, %	3.6	3.0	3.1	2.6	3.2	2.2	1.0	1.6	6.9	5.4	3.0
Total lignin, %	4.8	7.1	5.3	9.6	18.0	10.5	1.3	3.4	20.0	11.7	7.3
Nonlignin yield, %	47.5	47.5	47.5	45.6	48.3	44.9	43.4	44.6	52.5	50.5	47.6
Lignin, % on oven-dry wood	2.4	3.6	2.7	4.8	10.6	5.3	0.6	1.6	13.1	6.8	3.8
Sulphur, % in pulp	...	...	...	...	0.988	0.695	...	...	0.924	0.579	...
Sulphur, % on total lignin	...	...	...	...	5.5	6.6	...	...	4.6	4.9	...

[a] Dihydroquercetin.

rate, to attain serious proportions before the delignification is completed. Any sulphite cook might be considered a race between two over-all reactions—the desired series of reactions which result in wood delignification, and the bisulphite decomposition reactions. The decomposition, which occurs primarily toward the end of the cook, forms sulphuric acid which precipitates as calcium sulphate and thereby reduces the supply of available calcium. A satisfactory sulphite cook is characterized by the approximate completion of the delignification before the sulphuric acid formation becomes a serious competitor for base. The Douglas-fir lignin removal is only partially completed when the available calcium is precipitated by the sulphate formed in the bisulphite decomposition.

The Reason for Retarded Bisulphite Decomposition

The data of Table IV showed that dihydroquercetin, a strong promoter of bisulphite decomposition in the absence of wood, did not show this effect in the presence of wood. The yellow color of the pulps indicated that quercetin had been formed, and, presumably, bisulphite had been reduced to thiosulphate.

The effect of thiosulphate was studied in two sodium-base cooks of spruce, conducted in a 38-liter digester with indirect steam heating. These were 10-hr. cooks with a maximum temperature of 140°C. The cooking liquor contained 1.25% combined sulphur dioxide and 6.00% total sulphur dioxide. The only difference between the cooks was the addition of 7 millimoles per liter of thiosulphate to the starting liquor of the second cook. This amount of thiosulphate would be formed by complete oxidation of 2.1% dihydroquercetin, with a liquor ratio of 5 to 1. Liquor analyses were made at various intervals throughout the cooks. The thiosulphate concentration curves are shown in Fig. 2. The brightness values, permanganate numbers, screenings, and yields of these pulps were practically the same and the differences probably were not significant.

The thiosulphate concentration curves show that wood, or its reaction products, removes thiosulphate from the liquor during the early portions of the cooking cycle. The removal of thiosulphate catalyst retards the bisulphite decomposition that would have occurred in the absence of wood.

In apparent agreement with these results, Stockman (*25*) found that formic acid, equivalent to $5^1/_2$ millimoles per liter of thiosulphate, caused serious decomposition in the absence of wood, but had very little effect on a spruce cook. With formic acid equivalent to 22 millimoles per liter of thiosulphate, the spruce cooks were seriously damaged. In the latter case the wood probably did not remove enough thiosulphate to prevent serious bisulphite decomposition.

The Effect of Quercetin in the Pulp

Sulphite pulps, obtained from wood containing dihydroquercetin, are bright yellow when blown and change to a dull yellow or tan upon standing. Ferric chloride stain reactions indicated the presence of phenolic material which appeared to be quercetin. The yellow color cannot be removed by extraction with hot water, alcohol, acidified alcohol, or acetone.

Quercetin was found to consume permanganate in an approximately quantitative reaction. Results indicated that a quercetin content of 0.75% in the pulp increases the permanganate number 10 points. Large amounts of quercetin increase the results of the lignin determinations and completely change the shape of the ultraviolet absorbance curves from the lignin filtrates. However, the ultraviolet absorbance curves showed that the amount of quercetin in the yellow pulps was probably too small to cause serious error in the lignin analyses.

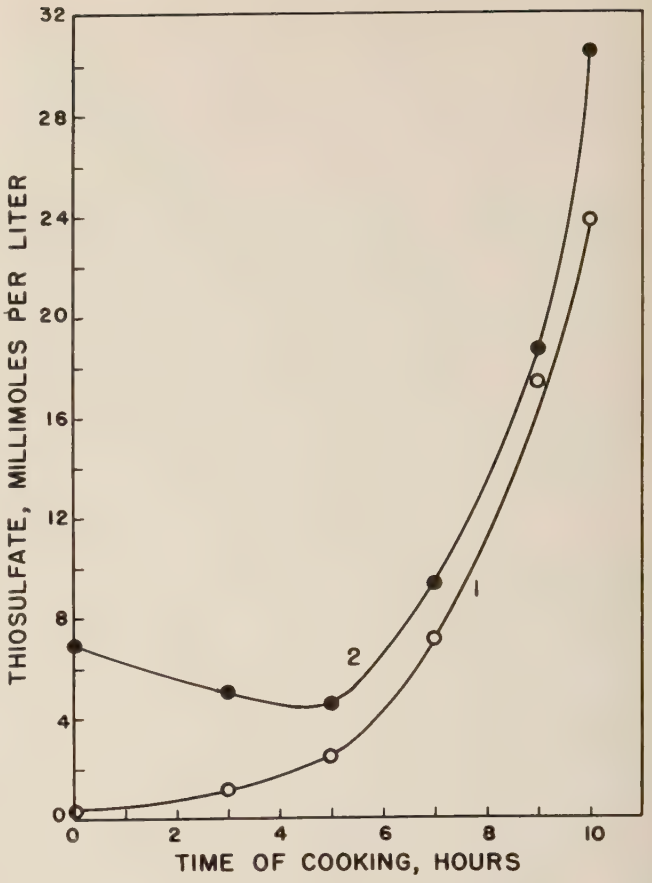


Fig. 2. The thiosulphate concentration in sulphite cooks plotted against time

1—No liquor additive. 2—Thiosulphate added to cooking liquor.

The Effect of Cooking Conditions

The effect of maximum pulping temperature, the effect of different liquor bases, and the behavior of dihydroquercetin were studied in four Douglas-fir cooks. Calcium-base cooks were made with maximum temperatures of 130 and 140°C. Intermediate liquor samples were analyzed for combined sulphur dioxide and the cooks were blown 15 min. after the liquor samples showed that the base had been consumed. These cooks were then repeated with sodium-base liquors, using the same pulping times. The analyses of the pulps and the final liquors from these cooks are shown in Table V.

The maximum cooking temperature had little effect on the lignin in the pulps and, using calcium-base liquors, high temperatures appeared to be beneficial, particularly in regard to screenings. These results disagree with the findings of Chidester and McGovern (*5*) and Brookbank (*7*), who reported that decreased maximum temperatures tend to decrease the screen-

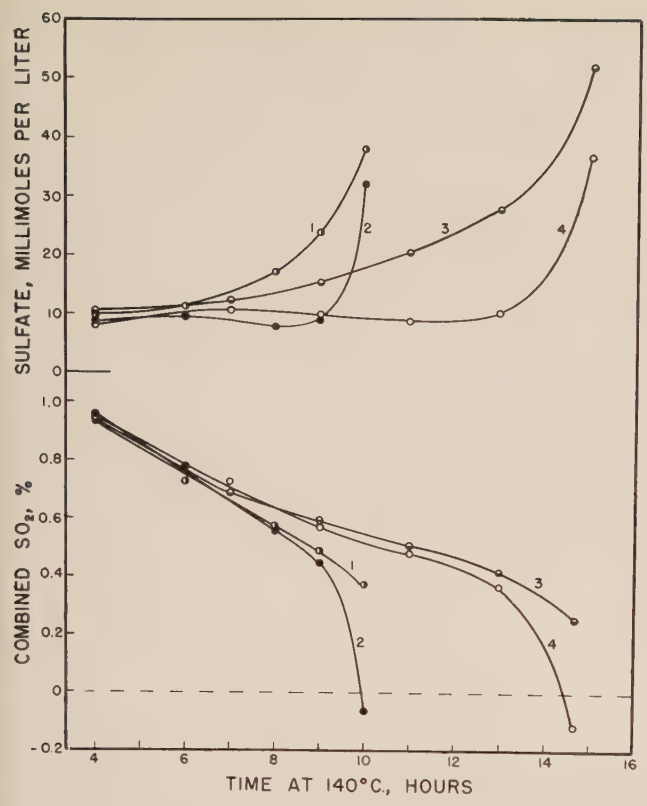


Fig. 3. The dissolved sulphate and combined SO_2 concentrations in liquors from Douglas-fir cooks plotted against time

1—Sodium base, 140°. 2—Calcium base, 140°. 3—Sodium base, 130°. 4—Calcium base, 130°.

Table V. Douglas-Fir Pulping Comparisons

Cooking liquor: 1.25% combined SO_2, 6.00% total SO_2. Liquor ratio: 6 to 1. Temperature schedule, 130° cooks: 1 hr. to 90°, 3 hr. from 90 to 115°, 1 hr. from 115 to 130°, $10^1/_4$ hr. at 130°C.; maximum pressure 75 p.s.i. Temperature schedule, 140° cooks: 1 hr. to 90°, 3 hr. from 90 to 115°, 2 hr. from 115 to 140°, $4^1/_4$ hr. at 140°C.; maximum pressure 85 p.s.i.

	Cook			
	Ca-130	*Na-130*	*Ca-140*	*Na-140*
Maximum temperature, °C.	130	130	140	140
Cooking liquor base	Ca	Na	Ca	Na
Total cooking time, hr.	$15^1/_4$	$15^1/_4$	$10^1/_4$	$10^1/_4$
Final spent liquor[a]				
pH	0.92	1.52	0.90	1.31
Sulphate, mmol./l.	37.0	52.2	32.3	38.1
Thiosulphate, mmol./l.	21.0	19.5	27.1	22.2
Combined SO_2, %	−0.11	0.26	−0.06	0.38
Free SO_2, %	1.50	1.90	1.33	2.10
Pulp				
Total yield, %	51.4	51.0	47.7	51.0
Screened yield, %	40.3	50.8	43.6	50.1
Screenings, %	21.6	0.5	9.0	1.8
Permanganate number				
Total yield	28.3	21.6	29.9	26.3
Screened yield	24.2	..	25.8	25.7
Alcohol solubility, %	1.19	0.86	1.14	0.87
Insoluble lignin, %	5.7	2.0	4.8	3.0
Soluble lignin, %	1.9	3.2	1.4	3.5
Total lignin, %	7.6	5.2	6.2	6.5
Nonlignin yield, %	47.4	48.4	44.8	47.2
Lignin, % on oven-dry wood	3.9	2.7	3.0	3.3

[a] The final liquor samples were obtained 15 min. before the cooks were blown.

ings in Douglas-fir pulps. However, the high screenings in the calcium-base pulps of Table V could have been the result of the increased acidity which accompanied the complete exhaustion of the base.

The intermediate liquor samples from these cooks were studied chromatographically to observe changes involving dihydroquercetin. Dihydroquercetin was present in the liquor during the first 7 hr. of the 140° cooks and the first 9 hr. of the 130° cooks. Its presence or absence in the last hours could not be determined chromatographically because other liquor components caused dark backgrounds on the chromatograms. Quercetin was present in small amounts in the 4-hr. samples and appeared to increase as the cooks were continued. If dihydroquercetin or quercetin acted as a strong phenolic inhibitor, these compounds would have been quantitatively removed from the cooking liquor during the early portion of the cook.

The pulping characteristics of Douglas-fir with sodium and calcium-base liquors are shown in Table V. The lignin contents and the permanganate numbers of the pulps are roughly the same. However, the pH and the combined sulphur dioxide concentrations of the final spent liquors are very different. The slower removal of available base from sodium-base liquors allows the use of longer cooking times before the base is exhausted; the increased time of cooking permits more complete delignification of the pulp.

The extended availability of the base in sodium-base cooks appears to be at least partially dependent on the sulphate formation. The curves of dissolved sulphate and combined sulphur dioxide versus time are shown in Fig. 3. In calcium-base cooks the sulphuric acid precipitates as calcium sulphate, requiring 2 equivalents of calcium per mole of sulphuric acid. In sodium-base cooks the base neutralizes the sulphuric acid to form sodium sulphate, and eventually sodium bisulphate. Richter (*38*) has shown that liquors of sodium bisulphate and sulphurous acid have almost the same pulping effect as sulphurous acid alone; pulping is seriously hindered only when free sulphuric acid is present. Therefore, in sodium-base cooks only 1 equivalent of base is required to sufficiently neutralize 1 mole of sulphuric acid to prevent the acidity from becoming harmful. The reduced amount of base which is required to neutralize a given amount of sulphuric acid in soluble-base cooks causes these liquors to be advantageous in the sulphite pulping of any species of wood which requires extended cooking times.

LITERATURE CITED

1. Wells, Sidney D., and Rue, John D., The suitability of American woods for paper pulp. U. S. Dept. Agriculture Bull. No. 1485. Washington, U. S. Govt. Print. Off., 1927, 102 pages.
2. Beuschlein, W. L., *Paper Trade J.* 88, No. 19: 66–67 (*T.S.* 147–148) (May 9, 1929).
3. Bailey, A. J., *Paper Ind.* 16: 480–483(1934).
4. Brookbank, E. B., and Brauns, F. E., *Paper Trade J.* 110, No. 5: 33–35(*T.S.* 55–57) (Feb. 1, 1940).
5. Chidester, G. H., and McGovern, J. N., *Paper Trade J.* 110, No. 11: 39–42(*T.S.* 145–148) (March 7, 1940); *Tech. Assoc. Papers* 23: 322–325 (1940).
6. Pew, John C., A flavanone from Douglas-fir heartwood. Forest Products Laboratory Report R1692. Madison, Wis., 1947. 17 pages: *Tappi* 32: 39–41(1949).
7. Brookbank, E. B., Jr., *Paper Trade J.* 108, No. 7: 30–38 (*T.S.* 68–76) (Feb. 16, 1939); *Tech. Assoc. Papers* 22: 556–564(1939).
8. Chidester, G. H., and McGovern, J. N., *Paper Trade J.* 113, No. 9: 34–38(*T.S.* 98–102) (Aug. 28, 1941); *Tech. Assoc. Papers* 24: 226–230 (1941).
9. Hatch, R. S., and Holzer, W. F., "Pacific coast pulpwoods," *in* TAPPI Monograph Series, No. 4, especially page 160, New York, Technical Association of the Pulp and Paper Industry, 1947.

10. Bialkowsky, H. W., Personal communication, 1953.
11. Erdtman, Holger, *Tappi* 32: 303–305(1949).
12. Erdtman, Holger, *Svensk Papperstidn.* 42: 344–349(1939).
13. Erdtman, H., *Cellulosechemie* 18: 83–92(1940).
14. Migita, Nobuhiko, Makano, Junzs, Sakai, Isamu, and Ishi, Soichi, *J. Japanese Tech. Assoc. Pulp Paper Ind.* 6: 476–480 (1952).
15. Adler, Erich, and Stockman, Lennart, *Svensk Papperstidn.* 54:477–482(1951).
16. Kurth, E. F., and Chan, F. L., *J. Am. Oil Chemists Soc.* 28: 433–436(1951).
17. Kurth, E. F., *Ind. Eng. Chem.* 45: 2096–2097(1953).
18. Foerster, F., Lange, F., Drossbach, D., and Seidel, W., *Z. Anorg. allgem. Chem.* 128: 245–342(1923).
19. Klason, Peter, *Wochbl. Papierfabr.* 41: 464–468, 541–547 (1910).
20. Anderson, M. S., and McKnight, G. S., Jr., *Tappi* 36: 151–153(1953).
21. Routala, O., and Pohjola, A., *Finnish Paper and Timber J.* 16: 289–290, 292–294, 296(1934).
22. Hagglund, Erik, Johnson, Torsten, and Urban, Helmut, *Ber.* 63B: 1387–1395(1930).
23. Hagglund, Erik, *Tek. Tid. Uppl. C. Kemi* 62: 49–50, 60–64(1932); *C.A.* 26: 6119.
24. Hagglund, Erik, and Menzinski, Georg, *Ber.* 68B: 822–824 (1935).
25. Stockman, Lennart, *Svensk Papperstidn.* 54: 621–627 (1951).
26. Kurtenacker, Albin, Analytische Chemie der Sauerstoffsauren des Schwefels, Stuttgart, F. Enke, 1938, 216 pages.
27. Sander, A., *Paper Trade J.* 71, No. 10: 50, 62(Sept. 2, 1920).
28. Samuelson, Olof, and Westlin, Arne, *Svensk Papperstidn.* 50, No. 11B: 149–154(1947).
29. Barton, John Selby, Reaction of lignin with acid sodium chlorite. Doctor's Dissertation. Appleton, Wis., The Institute of Paper Chemistry. 1948. 91 pages.
30. Browning, B. L., and Bublitz, L. O., *Tappi* 36: 452–458 (1953).
31. Hergert, Herbert L., and Kurth, E. F., *Tappi* 35: 59–66 (1952).
32. Barton, G. M., Evans, R. S., and Gardner, J. A. F., *Nature* 170, No. 4319: 249–250(1952).
33. Campbell, W. G., and McDonald, I. R. C., *J. Chem. Soc.* 1952: 3180.
34. Von Wacek, A., and Shroth, D., *Holz Roh- u. Werkstoff* 9: 7–11(1951).
35. Naghski, J., and Krewson, C. F., *J. Am. Pharm. Assoc.* 42: 66–68(1953).
36. Brauns, Friedrich Emil, "The chemistry of lignin," 808 pages, New York, Academic Press, 1952.
37. Brauns, F. E., "The proven chemistry of lignin," *in* TAPPI Monograph Series, No. 6, especially page 122, New York, Technical Association of the Pulp and Paper Industry, 1947.
38. Richter, George A., *Tappi* 36: 228–233(1953).

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A New Process for the Bleaching of Kraft Pulp with Sodium Peroxide

WILLARD F. SCHROEDER and JOHN R. SEFERIAN

The bleach response of sodium peroxide in the last bleaching stage has been improved considerably by means of an acid post-treatment to the preceding hypochlorite stage. In this post-treatment technique, the pulp at the completion of the hypochlorite stage is adjusted to a pH of 5 with a mineral acid at low density, washed after a short treatment time, and bleached with an alkaline peroxide solution in the last stage. With the proper use of this process, it has been found possible to produce bleached kraft pulps in the mid-80's with superior brightness stability and strength properties. This new process is readily adaptable to most existing multistage bleacheries which have used only hypochlorite and alkaline extraction treatments in the latter stages of the bleaching process.

During the last decade there has been great interest in the kraft pulp industry for the production of bleached pulps which have brightness values above 80 and still maintain good strength properties and brightness stability. Both alkaline peroxide and chlorine dioxide have been considered as bleaching agents in the final stages of the bleaching process in order to produce these desirable high brightness pulps.

Casciani and Storin (*1*) showed that the use of an alkaline peroxide solution in the last bleaching stage produced a more bright stable pulp than either chlorine dioxide or hypochlorite. This trend has been consistently proved by the sodium peroxide bleaching data of the Ashtabula Laboratory of National Distillers Chemical Co.

Alkaline peroxide solution was found by Staudinger and Jurisch (*2*) to have less degrading action on cotton cellulose than did hypochlorite as indicated by viscosity measurements. McEwen, Sheldon, and Nelson (*3*) showed that kraft and sulphite pulps which were bleached with alkaline peroxide solutions had higher viscosity values than pulps which had been bleached with hypochlorite.

The bleach response of the peroxide in the last stage had been found generally to be lower than that of chlorine dioxide. The use of sodium peroxide in the last alkaline extraction stage followed by a final hypochlorite stage had been advocated as a means of improving the final pulp brightness (*4*), but the brightness stability of the final pulp was not optimum for this application of peroxide because of the final hypochlorite stage. The superbleaching of kraft pulp with alkaline peroxide solutions at very high consistency for long time periods had also been advocated as a means of improving bleach response (*3*). The brightness stability of the pulp bleached in this manner has been found to be poorer than when the pulp was peroxide bleached at elevated temperatures for a short period of time. For the integrated mill, this technique requires a large storage area for the bleaching pulp and a capital expenditure for additional equipment and results in a high labor cost and inflexibility of operation.

The work described in the present report was carried out to study the means of improving the bleach re-

Willard F. Schroeder, Technical Service Engineer, and John R. Seferian (deceased, Sept. 23, 1953), Technical Service Department, National Distillers Chemical Co., Division of National Distillers Products Corp., Ashtabula, Ohio.

sponse of sodium peroxide in the last bleaching stage of normal bleaching processes where the peroxide could be used to its best advantage for brightness stability. As the result of this study, a process was developed for the marked improvement of the bleach response when sodium peroxide was used in the last bleaching stage.

EXPERIMENTAL METHODS

The pulps chosen for this work were an unbleached western hemlock kraft pulp and an unbleached southern pine kraft pulp. Both pulps had been produced commercially in pulp mills and were received and stored at approximately 32% oven-dry consistency. The western hemlock pulp had a permanganate number of 17.3, a brightness of 21.8, and a cupriethylenediamine viscosity of 20.1 cp. The southern pine pulp had a permanganate number of 18.2, a brightness of 22.0, and a cupriethylenediamine viscosity of 20.4 cp.

All figures expressed in percentage are based on the moisture-free weight of the pulp.

Experimental Procedures

The pulp, in batches of 900 to 1000 grams of moisture-free fiber, was thoroughly defibered in a 10-gal. container with a Lightnin mixer and soaked 16 hr. The pulp was then thickened in a pulp centrifuge. Chlorine water was added to a sufficient quantity of dilution water in a 10-gal. stoneware crock to obtain a final pulp consistency of 3.5% and a temperature of 67 to 68°F. After ascertaining the amount of available chlorine in the crock to be correct, the pulp was added to the chlorine water and agitated slowly with the stainless steel impeller of the Lighnin mixer.

The treatments with caustic soda and with various bleaching agents were carried out in stoneware crocks or stainless steel containers immersed in constant temperature water baths. In the high density caustic extraction and hypochlorite treatments, the chemical reagents were diluted with the correct volume of hot water, and the solution was then added to the pulp. The pulp at the desired consistency was mixed thoroughly for 2 min. in a Hobart mixer having a stainless steel agitator and container and was then transferred to a stoneware crock or another stainless steel container where the pulp was agitated frequently by hand using a long rubber glove during its treatment time.

In the sodium peroxide treatments, a stock solution was prepared which contained 20 grams per liter sodium peroxide and the proper proportion of other chemicals. The correct aliquot was added to hot water and blended with pulp, as described above. In the acid post-treatment, the desired amount of acid was blended with the dilution water and added to the high density pulp and agitated by the Lightnin mixer.

At the end of each treatment, the pulp was placed in a screen box and thoroughly washed with tap water and thickened in a pulp centrifuge to about 22 to 25% consistency. The pulp cake was then broken up by hand into crumbs, carefully mixed, and stored in polyethylene bags until further treatment. Moisture tests were made on the pulp at the end of each bleaching stage so that an accurate quantity of pulp could be used for the subsequent bleaching stage or for tests on the fully bleached pulp.

Test Methods

Brightness determinations were made on a Hunter multipurpose reflectometer using the blue tristimulus filter. This reflectometer had been found to correlate well with the General Electric reflectometer. Pulp handsheets for brightness tests were prepared similarly to TAPPI Standard T 218 m-48. All pulps were diluted with distilled water and adjusted to a pH of 5.0 ± 0.5 prior to formation of handsheet. Viscosity determinations were made by the cupriethylenediamine procedure described in TAPPI Standard T 230 sm-50, using 0.5% pulp solution in capillary pipets. Bursting strength and Elmendorf tearing resistance values were obtained on handsheets made during the beater processing of the pulps by the method of TAPPI Standard T 220 m-45 and conditioned in accordance with TAPPI Standard T 402 m-49.

Since kraft pulp manufacturers are most concerned with the stability of the pulp brightness to heat aging, the bleached pulps were only tested for this factor. In the absence of a standard method for the purpose, the degree of brightness stability of the bleached pulps was evaluated by means of the following test. After determining the Hunter brightness values, the brightness handsheets were placed in a circulating air oven at 105°C. for 1 hr. and were then evaluated for brightness again.

GENERAL PULP BLEACHING PROCESSES

The chlorination and alkaline extraction treatments for both the western hemlock and the southern pine kraft pulps were kept constant for the entire bleaching

Table I. Data on the Chlorination, Alkaline Extraction, Hypochlorite, and Sodium Peroxide Bleaching Stages of Western Hemlock and Southern Pine Kraft Pulps

	Kraft pulp	
	Western hemlock	*Southern pine*
Stage 1 (Chlorination)		
Chlorine, %	4.5	5.0
Consistency, %	3.5	3.5
Temperature, °F.	68	67
Chlorination time, min.	60	45
Residual chlorine, %	0.13	0.35
Final pH	1.6	1.5
Brightness	21.8	22.5
Viscosity, cp.	15.3	16.0
Stage 2 (Extraction)		
Sodium hydroxide, %	2.4	2.0
Consistency, %	16	13
Temperature, °F.	160	155
Time, hr.	1.5	2
Brightness	31.3	28.8
Viscosity, cp.	19.4	19.5
Stage 3 (Hypochlorite Bleach)		
Available chlorine, %	Tables III–XII	Tables II, XIV–XVI
Sodium hydroxide, %	Tables III–XII	Tables II, XIV–XVI
Consistency, %	16	13
Temperature, °F.	100–104	100–104
Bleaching time, hr.	1.5	Tables II, XIV–XVI
Final Stage (Sodium Peroxide Bleach)		
Sodium peroxide, %	Tables III–XII	Tables II, XIV–XVI
Sodium silicate, %	1.0	2.0
Sodium hydroxide, %	0.15	Tables II, XIV–XVI
Epsom salts, %	0.01	0.01
Consistency, %	16	13
Temperature, °F.	140–145	140–145
Bleaching time, hr.	1.5	2.0

study. Each pulp was given these two preliminary bleaching treatments, using the current bleaching conditions of the pulp mills which furnished the pulps. The third stage hypochlorite treatment of the western hemlock pulp was kept constant except for the percent available chlorine and the amount of sodium hydroxide used to control alkalinity. With one exception, the final stage sodium peroxide formula and bleaching conditions were kept constant. In the experiments on southern pine kraft pulp, the formula and bleaching time of the hypochlorite treatment were varied in order to study certain variables. With the exception of the sodium peroxide percentage and alkalinity, the conditions of the sodium peroxide treatment were kept constant. The data concerning these treatments are shown in Table I.

INITIAL EXPERIMENTS IN ACID TREATMENT OF PULP PRIOR TO SODIUM PEROXIDE TREATMENT

Alkaline Extraction Versus Acid Treatment

A bleaching study was being made on the unbleached southern pine pulp using high density hypochlorite, alkaline extraction, and sodium peroxide treatments as the last three stages of a five-stage process. The bleach response of the sodium peroxide treatment had been found to be mediocre and various means for improving it were being investigated.

As a laboratory procedure, it had been known that the treating of a kraft pulp with hydrochloric acid prior to a peroxide bleach often resulted in a better bleach response. It was assumed that the acid removed calcium from the hypochlorite bleached pulp which was believed to interfere with peroxide bleaching, or iron impurities from the pulp which catalytically decomposed the peroxide. Thus, it was decided to investigate the use of an acid treatment on this pulp. After the third-stage hypochlorite treatment, the pulp was divided into two portions and they were given an alkaline extraction and a sulphuric acid treatment, respectively. These pulps were then bleached with sodium peroxide in the final stage. The data covering the final three stages of these two bleaches are listed in Table II. Since the bleach response was improved so much by the acid treatment, this experiment was repeated and similar results were obtained.

Table II. Comparison of Alkaline Extraction and Acid Sour on Sodium Peroxide Bleach Response

Stage 3 (Calcium Hypochlorite Bleach)		
Available chlorine, %	2.5	
Sodium hydroxide, %	0.6	
Bleaching time, hr.	2.0	
Final pH	8.4	
Residual chlorine, %	0.34	
Brightness	79.9	
Stage 4 (Extraction and Acid Soak)		
Sodium hydroxide, %	1.0	...
Sulphuric acid, %	...	0.55
Consistency, %	12	3.5
Temperature, °F.	140	69
Time, hr.	1	0.5
Brightness	76.4	79.9
Stage 5 (Sodium Peroxide Bleach)		
Sodium peroxide, %	0.6	0.6
Final pH	10.8	11.0
Residual Na_2O_2, %	0.27	0.20
Brightness	81.7	85.2
Heat aging loss	2.9	3.4

Table III. Effect of Washing Hypochlorite Bleached Pulp Prior to an Acid Treatment

Stage 3 (Calcium Hypochlorite Bleach)			
Available chlorine, %		1.8	
Sodium hydroxide, %		0.4	
Final pH		8.55	
Residual chlorine, %		0.37	
Brightness		76.3	
Pulp washed	No	Yes	Yes
Stage 3b (Acid Treatment)			
Sulphuric acid, %	0.88	0.40	...
Consistency, %	4.0	4.0	...
Time, min.	30	30	...
Final pH	5.35	5.2	...
Brightness	78.8	76.9	...
Stage 4 (Sodium Peroxide Bleach)			
Sodium peroxide, %	0.35	0.35	0.35
Final pH	10.75	10.9	10.85
Residual Na_2O_2, %	0.03	0.03	0.01
Brightness	82.6	80.6	79.1
Brightness increment	6.3	4.3	2.8
Heat aging loss	3.0	3.3	3.3

Washing of Pulp Prior to Acid Treatment

At this time, the bleaching study on the southern pine kraft pulp was stopped temporarily, and a laboratory bleaching study was initiated on the western hemlock kraft pulp. The interested pulp mill had a four-stage process with high density equipment for the last three stages. They desired to reach a brightness of 74 to 76 at the end of the third stage and to bleach the pulp with a small amount of sodium peroxide in the fourth stage to a brightness of 80 in order to obtain a brighter, stronger, more brightness-stable pulp than they were currently producing. It was decided to investigate the use of an acid treatment on this pulp.

The first variable to be determined was whether the hypochlorite bleached pulp had to be washed prior to the sulphuric acid treatment since the mill had no extra vacuum washer available for a separate acid treatment stage. It was reasoned that it would be relatively simple to acidify the pulp leaving the bottom of the hypochlorite tower by adding the acid to the dilution water. At the end of the hypochlorite treatment, the pulp was divided into three portions. Two were washed in a normal manner, and the third was adjusted arbitrarily to a pH of 5 with sulphuric acid at 4% consistency and washed after 30 min. One of the portions of washed pulp was given an acid treatment under similar conditions and was washed. All three portions were then bleached with sodium peroxide. The data for this experiment are shown in Table III.

It was apparent that the sulphuric acid treatment worked successfully in the western hemlock kraft pulp and that the acidification of the pulp at the end of the hypochlorite treatment resulted in even higher brightness values for the peroxide bleached pulp.

DETERMINATION OF OPTIMUM CONDITIONS FOR ACID POST-TREATMENT OF HYPOCHLORITE BLEACHED PULP

Optimum pH for Acid Treatment

The next variable to be determined was the optimum pH for the acid post-treatment. At the end of the hypochlorite treatment on the western hemlock pulp the pulp was divided into four portions. One was

Table IV. Determination of Optimum pH Value for Acid Post-Treatment

Stage 3 (Calcium Hypochlorite Bleach)				
Available chlorine, %	2.0			
Sodium hydroxide, %	0.5			
Final pH	8.5			
Residual chlorine, %	0.37			
Brightness	73.7			
Stage 3b (Acid Post-Treatment)				
Acid	H_2SO_4	H_2SO_4	H_2SO_4	...
Consistency, %	4	4	4	...
Time, min.	15	15	15	...
Final pH	6.10	5.05	4.10	...
Brightness	75.7	76.1	76.1	...
Stage 4 (Sodium Peroxide Bleach)				
Sodium peroxide, %	0.5	0.5	0.5	0.5
Final pH	11.15	11.1	11.15	11.2
Residual Na_2O_2, %	0.16	0.17	0.19	0.14
Brightness	80.3	81.5	81.3	78.8
Brightness increment	6.6	7.8	7.6	5.1

washed and the other three were adjusted to pH values of 4.1, 5.0, and 6.1 at 4% consistency. After 15 min. the pulps were washed, and all four portions were bleached with sodium peroxide. The data for this study are shown in Table IV. The effect of post-treatment pH was checked several times, and each time the data showed that a pH of 5 gave slightly better results than a pH value of 4. This indicated that the optimum pH for the acid post-treatment was also the pH where the hypochlorous acid concentration was at its maximum (*5*). It was apparent that the acidification of hypochlorite bleached pulp resulted in two simultaneous effects: (1) a hypochlorous acid bleach and (2) a beneficial acid treatment prior to the peroxide bleach.

Effect of the Post-Treatment Acidifying Agent upon Sodium Peroxide Bleach Response

As the next step in the investigation of this acid post-treatment technique, various acidifying agents which are commonly used in the pulp and paper industry were used to lower the pH of the western hemlock hypochlorite bleached pulp. These acidifying agents were sulphuric and hydrochloric acids, sulphur dioxide, and papermaker's alum. The data for this bleaching study are shown in Table V.

Table V. Effect of Post-Treatment Acidifying Agent upon Sodium Peroxide Bleach Response

Stage 3 (Calcium Hypochlorite Bleach)				
Available chlorine, %	2.0			
Sodium hydroxide, %	0.45			
Final pH	0.5			
Residual chlorine, %	0.40			
Brightness	78.0			
Stage 3b (Acid Post-Treatment)				
Acidifying agent	H_2SO_4	HCl	SO_2	Alum
Consistency, %	4	4	4	4
Time, min.	15	15	15	15
Final pH	4.1	4.1	4.2	5.1
Brightness	78.5	78.6	77.8	74.8
Stage 4 (Sodium Peroxide Bleach)				
Sodium peroxide, %	0.35	0.35	0.35	0.35
Final pH	10.7	10.7	10.8	10.7
Residual Na_2O_2, %	0.03	0.05	0.07	0.05
Brightness	81.8	82.0	81.3	79.5
Brightness increment	3.8	4.0	3.3	1.5
Heat aging loss	3.0	2.8	3.3	...

Table VI. Acid Post-Treatment of Sodium Hypochlorite Bleached Pulp

Stage 3 (Sodium Hypochlorite Bleach)			
Available chlorine, %	1.6		
Sodium hydroxide, %	0.35		
Final pH	9.2		
Residual chlorine, %	0.38		
Brightness	72.5		
Stage 3b (Acid Post-Treatment)			
Acid used	H_2SO_4	HCl	...
Acid, %	1.15	0.75	...
Consistency, %	4	4	...
Time, min.	15	15	...
Final pH	5.05	5.2	...
Brightness	74.2	74.6	...
Stage 4 (Sodium Peroxide Bleach)			
Sodium peroxide, %	0.35	0.35	0.35
Final pH	10.95	10.9	10.95
Residual Na_2O_2, %	0.13	0.13	0.15
Brightness	80.8	80.9	76.6
Brightness increment	8.3	8.4	4.1

It can be seen from these data that an additional increase in brightness was obtained in the post-treatment because of the hypochlorous acid bleach. The use of sulphur dioxide, an acid reducing agent, conditioned the pulp satisfactorily for the peroxide bleach but it consumed the residual available chlorine without increasing the pulp brightness. Papermaker's alum reacted unfavorably with the residual hypochlorite such that a large loss in brightness occurred in the hypochlorite post-treatment.

Use of an Acid Post-Treatment on a Sodium Hypochlorite Bleached Pulp

The original premise for an acid treatment of kraft pulp prior to the peroxide bleach stage was for the removal of calcium ions and/or calcium bleach residues which were believed to inhibit the peroxide bleach response. To determine whether this theory was correct, the western hemlock kraft pulp which had been chlorinated and extracted with sodium hydroxide was given a sodium hypochlorite treatment in the third stage. At the end of the bleaching time, two portions of the pulp were acidified with sulphuric and hydrochloric acid at 4% consistency and pH 5 for 15 min. and were then washed. As a control bleach, a third portion of the hypochlorite bleached pulp was washed in a normal manner, and it and the two acid-treated pulps were

Table VII. Effect of Acid Post-Treatment Time upon Final Pulp Brightness

Stage 3 (Calcium Hypochlorite Bleach)					
Available chlorine, %	1.8		1.7		
Sodium hydroxide, %	0.4		0.35		
Final pH	8.2		7.8		
Residual chlorine, %	0.25		0.07		
Brightness	76.7		74.9		
Stage 3b (Sulphuric Acid Post-Treatment)					
Time, min.	5	15	30	1	10
Consistency, %	4	4	4	4	4
Final pH	5.15	5.1	5.2	4.7	5.2
Brightness	78.0	78.3	79.2	75.5	75.8
Stage 4 (Sodium Peroxide Bleach)					
Sodium peroxide, %	0.35	0.35	0.35	0.35	0.35
Final pH	10.75	10.7	10.75	10.7	10.75
Residual Na_2O_2, %	0.06	0.04	0.04	0.03	0.03
Brightness	81.5	81.4	82.1	79.1	79.5

Table VIII. Effect of Pulp Consistency in the Acid Post-Treatment upon Peroxide Bleached Pulp Brightness

Stage 3 (Calcium Hypochlorite Bleach)		
Available chlorine, %	1.8	
Sodium hydroxide, %	0.4	
Final pH	8.55	
Residual chlorine, %	0.37	
Brightness	76.3	
Viscosity, cp.	9.1	
Stage 3b (Sulphuric Acid Post-Treatment)		
Consistency, %	4	12
Time, min.	30	30
Final pH	5.35	4.50
Brightness	78.8	79.6
Stage 4 (Sodium Peroxide Bleach)		
Sodium peroxide, %	0.35	0.35
Final pH	10.75	10.7
Residual Na_2O_2, %	0.03	0.03
Brightness	82.6	83.2
Brightness increment	6.3	6.9
Viscosity, cp.	7.9	7.1

bleached with sodium peroxide. These data are shown in Table VI.

These results showed that the acid post-treatment produced over 50% improvement in peroxide bleach response on a pulp which had never been in contact with calcium ions, except for the minute quantities contained in the process waters. Also, sulphuric acid should not remove calcium from the pulp since an insoluble calcium sulphate would be formed. Based on these data, it is concluded that the acid post-treatment at pH 4 to 5 has a much greater effect on peroxide bleach response than the presence or absence of calcium ions on the pulp. Possibly it is the noncationic radicals of the bleach residues remaining on the pulp which inhibit peroxide bleach response, and the acid treatment dissolves or alters them.

Effect of Acid Post-Treatment Time upon Final Pulp Brightness

Having established the optimum conditions for the above variables, the effect of the treatment time of the acid post-treatment upon final pulp brightness was investigated on the alkaline extracted western hemlock pulp. In one study, the hypochlorite bleached pulp was post-treated with sulphuric acid for 5, 15, and 30 min., washed, and bleached with sodium peroxide. In a second study, the acid treatment times were 1 and 10 min. The data on these experiments are found in Table VII.

Table IX. Effect of Temperature of the Acid Post-Treatment upon Peroxide Bleach Response

Stage 3 (Calcium Hypochlorite Bleach)		
Available chlorine, %	1.6	
Sodium hydroxide, %	0.35	
Final pH	8.4	
Residual chlorine, %	0.28	
Brightness	76.5	
Stage 3b (Sulphuric Acid Post-Treatment)		
Temperature, °F.	99	65
Consistency, %	4	4
Time, min.	15	15
Final pH	4.7	4.85
Brightness	78.9	78.9
Stage 4 (Sodium Peroxide Bleach)		
Sodium peroxide, %	0.35	0.35
Final pH	10.8	10.8
Residual Na_2O_2, %	0.10	0.09
Brightness	82.1	82.2

Table X. Effect of Washing the Acid Post-Treated Pulp Prior to the Sodium Peroxide Treatment

Stage 3 (Calcium Hypochlorite Bleach)		
Available chlorine, %	1.7	
Sodium hydroxide, %	0.35	
Final pH	7.9	
Residual chlorine, %	0.16	
Brightness	76.9	
Stage 3b (Sulphuric Acid Post-Treatment)		
Consistency, %	4	4
Time, min.	15	11
Final pH	4.85	4.60
Brightness	78.4	78.4
Pulp washed	Yes	No
Stage 4 (Sodium Peroxide Bleach)		
Sodium peroxide, %	0.35	0.35
Final pH	10.85	9.9
Residual Na_2O_2, %	0.10	0.04
Brightness	82.7	82.8

The data indicated that the acid post-treatment required only a short treatment time, e.g., a 1-min. treatment gave final brightness results within a half point of a 10-min. treatment. The acid post-treatment seemed to condition the pulp almost instantaneously for peroxide bleaching.

Effect of Pulp Consistency in the Acid Post-Treatment upon Peroxide Bleached Pulp Brightness

In this experiment, the hypochlorite bleached pulp pH was lowered with sulphuric acid at 4 and 12% consistency for 30 min. The pulp was washed and bleached with sodium peroxide. The data are shown in Table VIII.

While a high density acid post-treatment produced a slightly higher final pulp brightness, it also had an adverse effect upon the viscosity of the bleached pulp.

Effect of the Temperature of the Acid Post-Treatment upon Peroxide Bleach Response

Until this experiment was made, the acid post-treat-

Table XI. Effect of an Acid Post-Treatment upon a Final Stage Hypochlorite Bleach

Stage 3 (Calcium Hypochlorite Bleach)			
Available chlorine, %	1.8		
Sodium hydroxide, %	0.35		
Final pH	7.7		
Residual chlorine, %	0.16		
Brightness	78.0		
Stage 3b (Sulphuric Acid Post-Treatment)			
Consistency, %	4.0	...	
Time, min.	15	...	
Final pH	5.0	...	
Brightness	78.6	...	
Stage 4 (Calcium Hypochlorite Bleach)			
Available chlorine, %	0.5	0.5	
Sodium hydroxide, %	0.2	0.2	
Consistency, %	16	16	
Temperature, °F.	103	103	
Bleaching time, hr.	1.5	1.5	
Final pH	8.5	8.8	
Residual chlorine, %	0.18	0.18	
Brightness	83.8	82.8	
Brightness increment (4th stage)	5.2	4.8	

Table XII. Bleaching Data on the Pulps for Physical Strength Determinations

	Pulp bleach 34-14	34-15	34-16
Stage 3 (Calcium Hypochlorite Bleach)			
Available chlorine, %	1.7	1.6	1.6
Sodium hydroxide, %	0.35	0.35	0.35
Final pH	7.7	7.7	7.7
Residual chlorine, %	0.14	0.10	0.12
Brightness	76.9	76.8	76.3
Pulp washed	Yes	No	Yes
Stage 3b (Acid Treatment)			
Sulphuric acid, %	...	1.1	0.6
Consistency, %	...	4	4
Temperature, °F.	...	86	77
Time, min.	...	6	7
Final pH	...	5.3	4.6
Brightness	...	77.2	77.2
Stage 4 (Sodium Peroxide Bleach)			
Sodium peroxide, %	0.35	0.35	0.35
Final pH	10.65	10.75	10.60
Residual Na_2O_2, %	0.10	0.11	0.12
Brightness	80.8	82.5	82.5

ments had been made at approximately 80°F., the result of blending pulp at 100°F. with water at its ambient temperature. In this experiment, the hypochlorite bleached pulp was diluted with acidified water at temperatures of 55 and 100°F. After 15 min., the pulp was washed and bleached with sodium peroxide. The data are shown in Table IX. The temperature of the acid treatment within a normal operating range did not affect the peroxide bleach response.

Effect of Washing the Acid Post-Treated Pulp Prior to the Sodium Peroxide Treatment

In order to ascertain whether the acid-treated pulp was required to be washed prior to the peroxide bleaching stage, the following bleaching experiment was carried out on the western hemlock pulp. The hypochlorite bleached pulp was given an acid post-treatment at 4% consistency. One portion of the pulp was washed and the second portion was thickened sufficiently to allow the peroxide treatment to be made at 16% consistency. Both pulps were then bleached with

Table XIII. Effect of Acid Treatment of Hypochlorite Bleached Pulp upon the Physical Strength Properties

	Pulp bleach 34-14	34-15	34-16	Unbleached
At 500 ml. Canadian Standard Freeness				
Beating time, min.	25	25	25	37
Burst factor	1.00	1.04	1.00	1.13
Tear factor	1.70	1.81	1.85	1.85
Breaking length, meters	7320	7425	6980	8130
At 200 ml. Canadian Standard Freeness				
Beating time, min.	45	45	45	62
Burst factor	1.10	1.10	1.10	1.17
Tear factor	1.32	1.46	1.43	1.60
Breaking length, meters	8290	8450	8060	8755

sodium peroxide. The resultant data are listed in Table X and indicated that the post-treated pulp is not required to be washed thoroughly prior to the peroxide treatment but can be merely thickened in order to produce a more efficient peroxide bleach.

Effect of an Acid Post-Treatment upon a Final Stage Hypochlorite Bleach

Since the acid post-treatment consistently produced a marked improvement in peroxide bleach response, a study was made to determine if the same trend was exhibited for a final stage hypochlorite bleach. After a third-stage hypochlorite treatment, one portion of pulp was washed while the second portion was adjusted to pH 5 with sulphuric acid at 4% consistency for 15 min. and was then washed. Both pulps were bleached with calcium hypochlorite in the final stage. The data for this study are shown in Table XI. The data showed that the acid post-treatment only improved the hypochlorite bleach response by less than one half a brightness point.

Effect of Acid Treatment of Hypochlorite Bleached Pulp upon the Physical Strength Properties

Having established most of the optimum conditions for the acid post-treatment of a hypochlorite bleached pulp prior to a sodium peroxide final bleach, a study was made to determine the effect of an acid treatment on

Table XIV. Effect of the Alkalinity and Bleaching Time of the Hypochlorite Stage upon the Final Bleached Pulp Brightness and Viscosity

Stage 3 (Calcium Hypochlorite Bleach)								
Bleaching time, hr.	1	1.5	2	1	1.5	2		
Available chlorine, %	2.7	2.7	2.7	2.7	2.7	2.7		
Sodium hydroxide %	0.9	0.9	0.9	0.6	0.6	0.6		
Final pulp pH	10.35	9.6	8.85	8.6	8.0	7.6		
Residual chlorine, %	0.94	0.78	0.57	0.84	0.50	0.30		
Brightness	70.5	73.4	75.6	74.2	78.8	80.7		
Viscosity, cp.	10.3	9.6	9.1	10.5	9.2	8.1		
Stage 3b (Acid Post-Treatment)								
Sulphuric acid, %	1.7	1.6	1.4	...	1.5	1.3	1.2	...
Pulp pH	4.5	4.65	4.7	...	4.6	4.6	4.9	...
Brightness	76.0	77.3	79.3	...	78.8	81.0	81.8	...
Brightness increment	5.5	3.9	3.7	...	4.6	2.2	1.1	...
Viscosity, cp.	8.4	8.7	8.3	...	8.6	...	...	...
Stage 4 (Sodium Peroxide Bleach)								
Sodium peroxide, %	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sodium hydroxide, %	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Final pulp pH	10.25	10.3	10.4	10.6	10.3	10.3	10.4	10.5
Residual Na_2O_2, %	0.06	0.09	0.08	0.01	0.10	0.08	0.05	0.01
Brightness	83.6	84.2	84.2	78.4	83.4	84.6	84.7	81.3
Total brightness increment	13.1	10.8	7.6	2.8	9.2	5.8	4.0	0.6
Viscosity, cp.	8.1	8.1	7.7	8.0	7.7	7.1	6.5	6.8

washed and unwashed hypochlorite bleached pulp upon the physical strength properties of pulp after it had been treated with sodium peroxide in the final stage. Using the same batch of chlorinated and alkaline extracted western hemlock kraft pulp, three third-stage hypochlorite bleaches were made. Two of the pulps were washed at the completion of the bleach and the third was adjusted to pH 5.3 with sulphuric acid at 4% consistency and washed after 6 min. One of the washed pulps was treated with sulphuric acid at pH 4.6 and 4% consistency for a similar length of time and was then washed. All three pulps were then bleached with sodium peroxide. The bleaching data are shown in Table XII. The three bleached pulps and the unbleached kraft pulp were then refined in a standard laboratory beater test and the resultant handsheets were tested for the conventional strength properties. The physical strength data are shown in Table XIII.

With the use of an acid post-treatment or a separate acid treatment stage, it was possible to obtain a brighter pulp which exhibited higher bursting strength and tearing resistance than a pulp which had been bleached similarly except for the acid treatment. The pH values of these hypochlorite bleaches were allowed inadvertently to fall below the desired final value of 8.5 Had the alkalinity of these bleaches been higher, it is estimated that all the strength properties would have been closer to those of the unbleached pulp.

Effect of the Alkalinity and Bleaching Time of the Hypochlorite Stage upon the Final Bleached Pulp Brightness and Viscosity

In examining all the previous data, it was apparent that the hypochlorite bleaches with the higher residual amounts of available chlorine gave higher final brightness values because of the hypochlorous acid bleach. Also, the hypochlorite bleached pulps which had higher final pH values seemed to give better response in the sodium peroxide stage. To definitely prove this trend, a comprehensive study was made to determine the effect of bleaching time, pH, and the residual available chlorine of the hypochlorite stage upon the brightness and degree of degradation of the pulp in the acid post-treatment stage and in the final sodium peroxide stage.

The pulp used for this study was the southern pine kraft pulp on which the first experiment had been made. Two large hypochlorite bleaches were made at different alkalinities. At 1, 1½, and 2 hr., portions of pulp were removed, diluted to 4% consistency, and adjusted to pH 4.5 to 5.0 with sulphuric acid. After 15 min. the pulps were washed and thickened, and they were then bleached with 0.5% sodium peroxide. Also one portion of hypochlorite pulp from each bleach was merely washed and thickened after the 2-hr. bleaching time and was given a similar sodium peroxide bleach. Most of these pulps were tested for cupriethylenediamine disperse viscosity. All these data are shown in Table XIV.

Table XV. Comparison of an Acid Post-Treatment and a Hypochlorous Acid Bleach as to Their Effect upon Final Pulp Brightness

Stage 3 (Calcium Hypochlorite Bleach)				
Available chlorine, %		2.5		
Sodium hydroxide, %		0.85		
Bleaching time, hr.		1.5		
Final pH		9.8		
Residual chlorine, %		0.70		
Brightness		71.5		
Pulp washed	No	Yes	Yes	Yes
Stage 3b or 4 (Acid or Hypochlorous Acid)				
Sulphuric acid, %	1.45	0.29	0.39	...
Available chlorine, %	...	0.70	...	...
Consistency, %	4	4	4	...
Time, min.	15	15	15	...
Final pH	4.8	5.0	4.8	...
Brightness	76.5	75.4	73.1	...
Final Stage (Sodium Peroxide Bleach)				
Sodium peroxide, %	0.5	0.5	0.5	0.5
Sodium hydroxide, %	0.1	0.1	0.1	0.1
Bleaching time, hr.	2	2	2	2
Final pH	10.65	10.65	10.8	10.95
Residual Na_2O_2, %	0.12	0.05	0.19	0.02
Brightness	83.0	82.3	79.5	74.9
Brightness increment	11.5	10.8	8.0	3.4

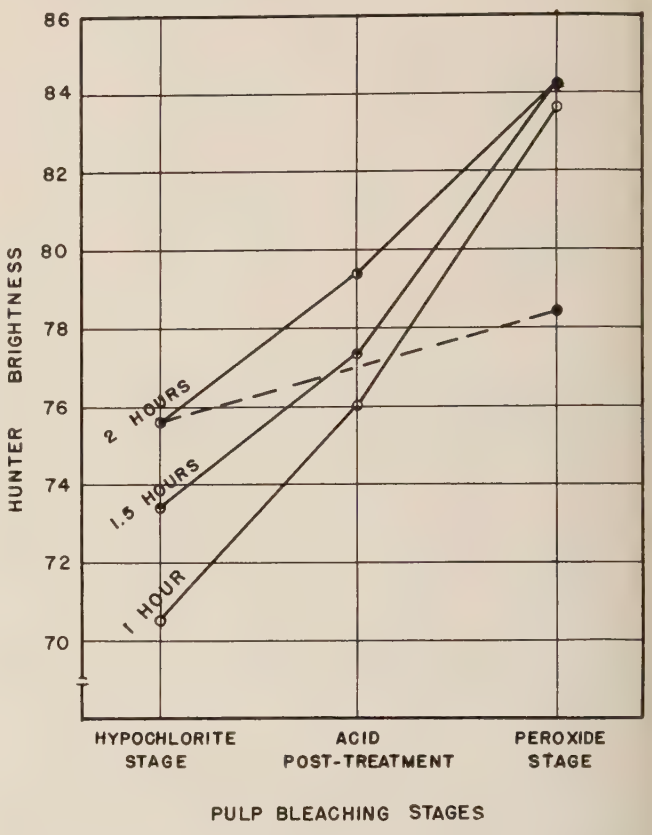

Fig. 1. Effect of hypochlorite bleaching time and acid post-treatment upon sodium peroxide bleach response

It was observed that it is possible to shorten the hypochlorite bleaching time by almost 50% and still obtain the same final brightness in the mid-80's when the pulp is given a post-treatment at pH 5 and then bleached with sodium peroxide. The comparison of the bleach response at various hypochlorite bleaching times is shown in Fig. 1. The peroxide bleached pulp which had a shorter hypochlorite bleaching time also exhibited less degradation. The use of a higher alkalinity than normal in the hypochlorite formula results in an equal brightness pulp with a higher viscosity.

Comparison of an Acid-Post-Treatment and a Hypochlorous Acid Bleach as to Their Effect upon Final Pulp Brightness

Since the acid post-treatment of hypochlorite bleached

pulp was, in effect, a hypochlorous acid bleach, a study was made to compare the final brightness of a post-treated pulp with one which had been given a similar treatment as a separate stage. At the end of the hypochlorite bleaching stage, one portion of pulp was adjusted to pH 4.8 and 4% consistency with sulphuric acid and a much larger portion was washed. The washed pulp was divided into three portions. One portion was adjusted to pH 5.0 with hypochlorous acid containing

Table XVI. Effect of the Consistency of the Peroxide Stage upon Bleach Response of Acid-Treated Pulp

Stage 3 (Calcium Hypochlorite Bleach)			
Available chlorine, %	2.5		
Sodium hydroxide, %	0.80		
Bleaching time, hr.	1.5		
Final pH	9.35		
Residual chlorine, %	0.65		
Brightness	73.0		
Stage 3b (Acid Post-Treatment)			
Sulphuric acid, %	1.3		
Consistency, %	4		
Time, min.	15		
Final pH	4.25		
Brightness	76.2		
Stage 4 (Sodium Peroxide Bleach)			
Sodium peroxide, %	0.5	0.5	
Sodium hydroxide, %	0.1	0.3	
Consistency, %	13	4	
Bleaching time, hr.	2	2	3
Final pH	10.65	10.70	10.65
Residual Na_2O_2, %	0.09	0.13	0.11
Brightness	83.3	82.2	83.0
Brightness increment	10.3	9.2	10.0

the same percentage of available chlorine as the pulp contained at the end of the hypochlorite stage. A second portion was given a sulphuric acid treatment at pH 4.8 and 4% consistency and the third portion was untreated in order to serve as a control. All four pulps were then bleached with sodium peroxide in the final stage. The data for this study are shown in Table XV.

The data showed that the acid post-treated pulp gave a slightly higher final pulp brightness than the pulp treated with a separate hypochlorous acid stage and 3.5 points higher than the pulp treated with acid in a separate stage. Thus the acid post-treatment technique seemed to be the most efficient means of treating kraft pulp, prior to the peroxide bleaching stage.

Effect of the Consistency of the Peroxide Stage upon Bleach Response of Acid-Treated Pulp

Because of the lower oxidation potential of alkaline peroxide solutions, it had been found that much better bleaching efficiency was obtained when the peroxide bleaches were made at high density. Increasing the pulp consistency of the peroxide bleach from 4 to 13% consistency usually increased the brightness increment by 30% or more.

In this experiment, the southern pine pulp was bleached with calcium hypochlorite in the third stage and was then given a sulphuric acid post-treatment at 4% consistency for 15 min., after which it was washed. The pulp was then bleached with sodium peroxide at 4 and 13% consistency and 140°F. The results are shown in Table XVI.

The acid treatment of the pulp prior to the peroxide bleach conditioned the pulp so that it gave almost the same bleach response at low density as it gave at high density.

CONCLUSIONS

The following conclusions may be drawn from the previously-described investigation:

1. A mild acid treatment of kraft pulp prior to a final stage sodium peroxide bleach improved the bleach response by 50 to 100%.

2. The acidification of pulp at the completion of the hypochlorite bleaching treatment resulted in a dual effect of a hypochlorous acid bleach and a favorable conditioning treatment for the final peroxide bleaching stage.

3. The optimum conditions for the acid post-treatment of hypochlorite bleached pulp were found to be readily adaptable to existing kraft mill bleacheries. The pulp at the bottom of the hypochlorite bleaching tower can be simultaneously diluted to a pumping consistency and adjusted to a pH of 4.5 to 5.0 by the addition of sulphuric acid to the dilution water. After a short holding time of preferably 5 to 15 min. at the existing temperature, the pulp is washed and bleached with sodium peroxide in the final bleaching stage.

4. If the hypochlorite bleaching time is shortened to one half to two thirds of its normal length and the alkalinity is adjusted to give a pH value of about 9.5 prior to the acid post-treatment, it was found possible to obtain the same final brightness with the peroxide bleach and also to obtain higher viscosity values on the fully bleached pulp than when the hypochlorite bleaching time was of normal length.

5. The acid treatment of hypochlorite bleached pulp, either as a hypochlorous acid bleach or as an acid soak, does not affect adversely the physical strength properties of the peroxide bleached pulp.

6. The mineral acids, sulphuric acid and hydrochloric acid, were found to give equivalent results when used to lower the pH of the pulp in the post-treatment. Sulphuric acid would be preferred on the basis of cost, odor, and greater ease of handling. Sulphur dioxide, a reducing agent, did not produce as large an over-all brightness increment, because it eliminated the hypochlorous acid bleaching effect.

7. The acid post-treatment of hypochlorite bleached pulp did not affect adversely the brightness stability of the peroxide bleached pulp. The brightness stability of acid-treated pulp compared favorably with that of pulp which had been given an alkaline extraction prior to the peroxide bleach.

8. The acid treatment of pulp prior to the peroxide bleaching stage was found to have a much greater effect upon the peroxide bleach response than the presence or absence of calcium ions. This disagreed with the theory that calcium in the pulp was responsible for a poor peroxide bleach response.

9. The acid treatment of pulp was found to have very little effect upon the bleach response of a subsequent calcium hypochlorite bleaching stage. This acid treatment seemed to be specific for alkaline peroxide bleaches.

10. The use of an acid post-treatment after the hypochlorite bleaching stage to produce a hypochlorous acid bleach was found to give equivalent or better results

than if a similar hypochlorous bleach was used as a separate stage.

11. The use of an acid post-treatment after the hypochlorite bleaching stage conditioned the pulp so that a low density peroxide bleach gave almost the same bleach response as a high density peroxide final stage bleach.

12. By the use of the advocated procedure of acid post-treating a hypochlorite bleached pulp and then bleaching the pulp with alkaline peroxide in the final stage, it was found possible to produce a brighter, stronger pulp with equivalent brightness stability than if the hypochlorite bleached pulp had been alkali extracted prior to the peroxide treatment. The use of this bleaching procedure could also eliminate one of the bleaching stages from a five to seven-stage process and allow a brighter, stronger pulp to be produced.

LITERATURE CITED

1. Casciani, F., and Storin, G. K., *Tappi* 33, No. 12: 588–594 (1950).
2. Staudinger, H., and Jurisch, J., *Papier-Fabr.* 35: Tech. Tl. 462–469 (1937); *C.A.* 32: 2341.
3. McEwen, R. L., Sheldon, F. R., and Nelson, D. H., *Tappi* 34, No. 5: 193–201 (1951).
4. "Peroxide Bleaching of Sulfate Pulp," Brochure A-5118, E. I. du Pont de Nemours and Co. (1953).
5. Wise, L. E., "Wood Chemistry," 1st ed., page 736, New York N. Y., Reinhold Publishing Corp., 1944.

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Extending the Range of the NBS Stiffness Tester

VERNON WORTHINGTON

Two instruments suitable for measuring the stiffness of paper and a novel specimen cutter are described. One stiffness tester provides for two testing ranges, and is suitable for heavy papers and light cards. The second stiffness tester is suitable for very weak materials such as tissues. Some difficulties encountered in testing very weak materials are discussed, and certain test procedures are suggested.

Two years ago, a stiffness tester of novel design that could successfully cover the group of papers from newsprint to bonds was constructed and described (*1*).

Two new instruments have since been constructed: one, a dual range model for stiffer papers and materials up to the stiffness of playing cards; the other, a very low range model for low stiffness papers such as tissues. Certain new features have been introduced in these models, but the basic principle remains the same. The test strip is held as a cantilever in a vertical plane. The "clamped end" is caused to turn about a vertical "torque axis" by applying a torque to the clamp. The "free end" is restrained from rotating about the torque axis but is otherwise free. The torque is applied to the clamped end by means of torsion wires, and the torque for a selected angle of rotation of the clamped end is observed.

THE HIGH-RANGE TESTER

The new high-range machine retains the antifrictional and antigravitational principles of the prototype. The higher range is obtained by employing torsion wires of 0.011 in. diameter instead of 0.009 in. diameter as used in the earlier machine.

Construction is somewhat heavier throughout, but in this machine, as in the original, the torsion clamp is suspended between two torsion wires, which in turn are secured to either end of the movable frame that carries the force measuring scale.

Method of Changing Test Ranges

A method for obtaining an additional test range without the difficulty of changing torsion wires is incorporated in this tester (Figs. 1 and 2). Figure 2 shows only the upper portion of the frame F as the lower portion is similar. A short metal cylinder X is secured to the mid-section of each torsion wire W, the wires are attached to the clamp C and the frame F, as indicated at A. By means of the attendant mechanism (Z and Y) it is possible to snub, or in effect shorten each wire, thus increasing the torque.

The principle of snubbing the torsion wires seems to work well, and if it were desired to have additional ranges, it should be possible to design the tester with longer torsion wires and more than one snubbing position.

Machines of this type could be constructed in still higher test ranges, but it is evident that then some changes would become necessary, such as a different type of clamp and other means of applying forces. When measuring stiffer materials, the effects of gravity and friction are much less of a problem, and, moreover, this range is reasonably well covered by existing testers.

Operation of the Dual-Range Tester

The performance of the dual-range tester is similar to that of the original model. Although the torsion wire is thicker and a number of parts are made stronger, the test range is not so far removed from that of the former machine as to create many new problems.

The procedure for changing from one range to the other is relatively simple. It is only necessary to be certain that the pointer retains its zero position after any such change.

Snubbing the torsion wires to permit use of the high range is readily accomplished by first moving, in turn, each collar Y, Fig. 2, up around the cylinder X, and then tightening set screws Z, against them.

The collars are each cut away longitudinally on the side next to the screws, which permits free movement of them until these screws are tightened against the cylinders, when they then press the collars against the frame, immobilizing the whole assembly.

Calibration of the torsion wires by the method described in the previous paper (*1*) is made separately for each test range.

Vernon Worthington, Physical Science Aide, National Bureau of Standards, Washington, D. C.

Scope of the Dual-Range Tester

The median and probably the more precise portion of the range of the original instrument is from about 1.5 to 25 gram-cm., while the low range of the dual tester extends from about 4 to 60 gram-cm., and the high range is best from about 8 to 125 gram-cm. Each of these instruments may be used, with reasonable accuracy, somewhat above and below the median range, so that taken together the full capacity of the two testers is approximately 0.4 to 200 gram-cm.

Table I. Test Results Obtained on a Variety of Materials, with Overlapping of Test Ranges Where Possible

	Stiffness, gram-centimeters			
	Dual-range tester			
Identification of material[a]	*High range*	*Low range*	*Original tester*	*Ultra-low-range tester*
Playing cards, M.D.[a]	85.5	..	...	..
Playing cards, C.D.	49.8	..	...	..
50% Rag ledger, M.D.	20.9	20.4	19.9	.
50% Rag ledger, C.D.	10.1	9.9	10.1	...
100% Rag ledger, M.D.	5.6	5.3	5.7	..
100% Rag ledger, C.D.	3.3	3.0	3.1	...
Bread wrapping, M.D.	..	..	0.62	0.63
Bread wrapping, M.D.	..	..	0.53	0.54
Bread wrapping, M.D.	..	..	0.38[b]	0.34
Polyethylene plastic	..	..	...	0.227
Vinyl chloride plastic	..	..	...	0.207
50% Rag manifold	..	..	...	0.084
White tissue	..	..	...	0.056

[a] M.D. indicates that the test specimen was bent in the machine direction of the material, while C.D. indicates a like treatment for the cross direction.
[b] This paper was at the lower limit of the original tester.

It will be noted that there is a large overlap in the different ranges of the machines, thus making for easy comparison (Table I). In spite of the overlapping of ranges, each has its own uses, for sensitivity varies, being greatest for the range of the original tester and decreasing in ascending order for the two ranges of the

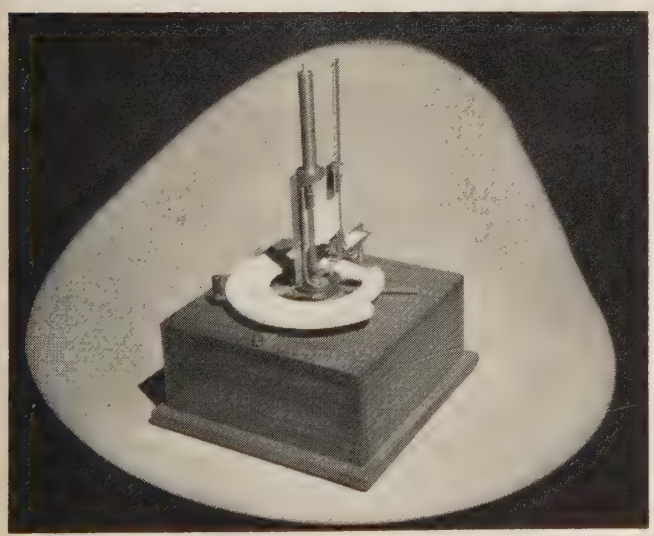

Fig. 1. The dual-range stiffness tester

dual instruments. The most sensitive range, consistent with the stiffness of the material that is being tested, should always be used. A sensitivity rating will be obtained if the calibration constant for any tester is multiplied by the shortest length that can be tested, and divided by the greatest test width. The approximate sensitivity rating for the original tester is 0.02 gram-cm. per degree, and for the low and high ranges of the dual-range tester the ratings are 0.06 and 0.13 gram-cm. per degree, respectively.

AN ULTRA-LOW-RANGE TESTER

Upon completion of the dual-range stiffness tester, attention was turned to the problem of testing weaker materials for stiffness. Many difficulties were immediately apparent. Very weak materials require

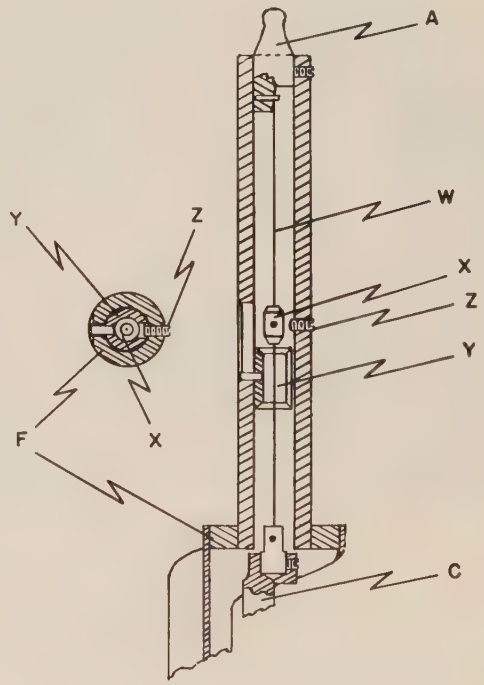

Fig. 2. Diagram showing the snubbing mechanism for the dual-range tester

shorter testing lengths than are possible in previous designs. All parts of a low-range tester require greater precision in construction. There is also the difficulty of working with a relatively small and weak torsion wire.

Details of Construction

To provide for unusually short testing lengths it is necessary to discard the suspension arrangement for the restraining clamp as used in the two previous testers and substitute a rigid frame support (Figs. 3 and 4). The frame support S for the restraining clamp K is provided with a locking device R that holds this clamp motionless while the specimen is being inserted. Slight changes are made in the torsion frame which make possible the testing of a specimen as short as 0.5 cm. A different style length setting device L that increases the precision is employed.

In view of the extremely delicate torsion wire, 0.004 in. in diameter, a guard G is provided which, when pushed downward, also doubles as a positioning and restraining device for the torsion clamp; thus both clamps can be temporarily constrained from movement while samples are inserted.

It is necessary to balance the restraining clamp K to avoid errors due to gravitational forces, and this tester, as well as each of the others, requires that the torsion clamp and pointer unit C be balanced.

A windshield is provided to enclose the clamps, and to cover the pointer.

Difficulties Attendant to Ultra-Low-Range Testing

The ultra-low-range instrument is extremely sensitive, so that undue vibration must be avoided. It is necessary to level the machine before using to preclude gravitational interference from the restraining clamp

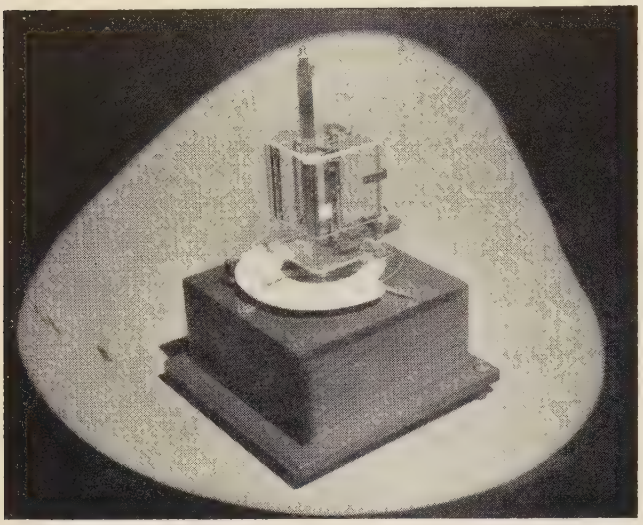

Fig. 3 The ultra-low-range stiffness tester

frame. It is possible, though unlikely, that the plastic windshield could become charged if rubbed too much in cleaning; however, a static charge is readily detected as an erratic behavior of the pointer when it is free to swing with the clamp closed and no specimen present.

Unusual care is required in all phases of very low range testing. The samples are very easily damaged in handling, and even the tester demands careful treatment because of the delicate torsion wire.

In this very low range, slight defects in test specimens may cause errors comparable to the actual stiffness of the material being tested.

Static charges may cause large errors with some materials, notably plastics, if the specimen is permitted to extend much beyond the restraining clamp.

The outstanding difficulty encountered in this range is that caused by sample defects, such as minute creases, striations, or slightly uneven surfaces. A material may appear to be flat and still cause trouble due to slight undulations, which introduce mechanical resistance to bending in addition to the normal or inherent resistance. When testing a material that is not completely free of undulations, the reading observed on the torque scale is the result of a counter force, consisting of both inherent and mechanical resistance. However, as the test is continued, the mechanical resistance is usually overcome, accompanied by a sudden reversal of the undulation and a corresponding reduction in the torque reading. A variation of the problem caused by undulatory material is that in which the undulation fails to reverse before the test is completed, showing no break in the steady movement of the force pointer throughout the test period and consequently giving no evidence of the condition.

Whenever suspicion is aroused by erratic behavior of the pointer or when the test force is very different for the two directions of bending, some extra precautions should be taken. More accurate results may be obtained when testing undulatory materials, if not only more than the usual number of tests are made, but also either larger angles or a number of different angles are used to increase the chances of overcoming the mechanical resistance before the chosen deflection is reached.

Undulatory phenomena are not unknown where stiffer materials are concerned, but are usually of little consequence, for here the mechanical forces are small compared to the inherent stiffness.

The curled or curved sample is entirely different from the above, and presents no problem, for the zero adjustment of the deflection scale is provided to overcome this difficulty.

Of the many problems encountered in very low-range testing, it is found that most are due to characteristics of the materials rather than the instrument, which itself seems quite capable of good performance.

Scope of the Tester

The testing range of this latest machine is from approximately 0.05 to 1 gram-cm., although as with the

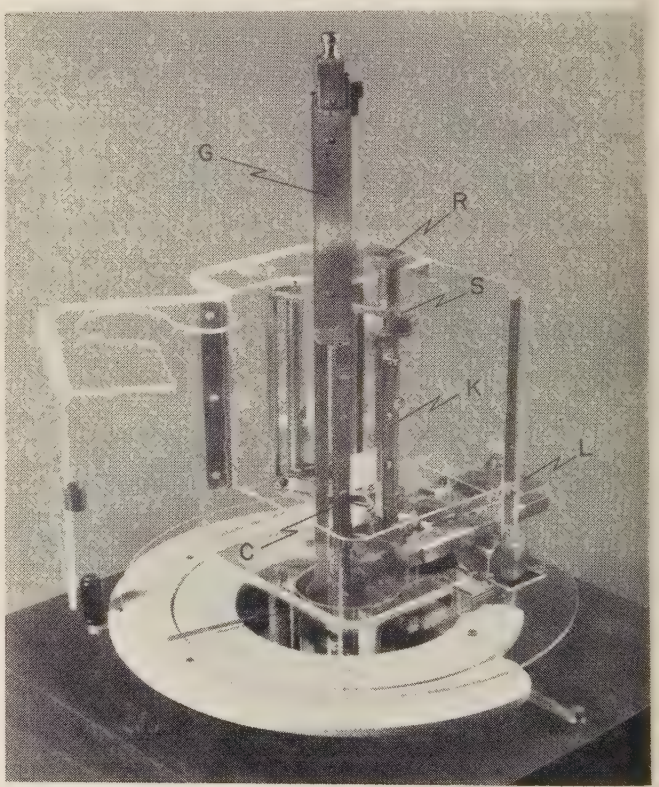

Fig. 4. Detail of the ultra-low-range stiffness tester

others, it may be extended somewhat if less accuracy is accepted.

The sensitivity rating is approximately 0.0006 gram-cm. per degree.

It was found that test lengths less than 0.5 cm. produced rather large errors and that even this length was often unsuitable. Therefore it is expedient to test lengths of 1 cm. and above where possible.

The range of the original tester and that of the ultra-low-range instrument barely meet, but comparative tests indicate that there is fair agreement between them (Table I).

Both paper and plastic sheets have been tested by this instrument, and it was found that the weak papers behave more or less in the manner common for heavier papers, except for characteristics previously noted. However, some plastics give trouble due to plastic flow.

It was noted that if tests on plastics were performed very slowly, permitting time for the flow to take place, fairly consistent results were possible. Some doubt has been expressed, however, as to the advisability of slow operation because of the increased risk of personal error which stems from the difficulty of deciding on a suitable test rate for each different material.

A SPECIAL SAMPLE CUTTER

Changing the width of a test specimen, to bring it into the test range of an instrument, causes much smaller variations in test results than does varying its length, but due to the relative ease of resetting the test length, this method has been largely used in the past.

A suitable cutter, capable of providing for many widths, has now been constructed.

The cutter (Fig. 5) consists of a small photographic paper trimmer, upon which a movable guide is mounted, capable of aligning one edge of the sample parallel to the knife, and at a predetermined distance from it. A pressure bar is placed near and parallel to the knife, between it and the guide, thus providing a means of holding the specimen while it is being cut. The guide

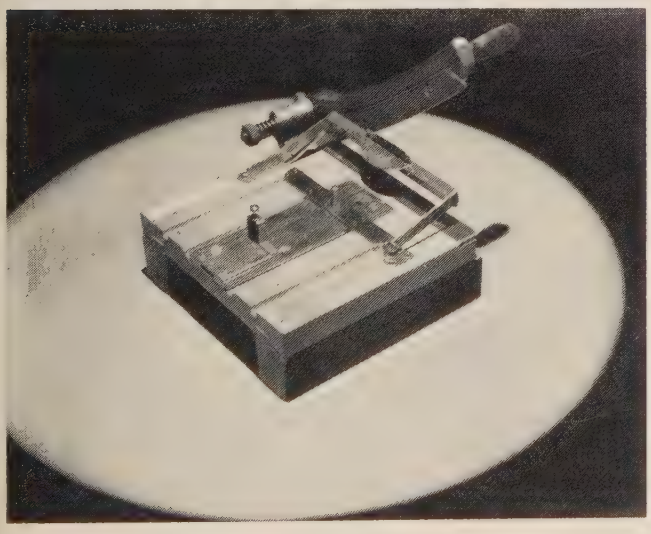

Fig. 5. Special cutter for stiffness samples

is so made that it can be locked at definite and fixed intervals, thus eliminating variable errors in adjustment for each setting. The settings of the guide provide for the accurate cutting of specimens at widths of 3.5, 4, 5, 6, and 7 cm. directly, and by recutting one of these wider strips, using a narrower strip setting, for all other widths from 0.5 to 3 cm. in 0.5-cm. steps, making a total of 11 possible widths. The object of this design is to avoid the cutting of a very narrow strip from a wide overhanging sheet, as then it is difficult to prevent skewing of the material, with resulting variable-width strips.

SIMPLIFICATION OF TEST PROCEDURE

In earlier work it had been shown that practically any combination of length, width, and deflection angle produced reasonably good results, and while it probably would also hold true for the ultra-low-range tester, it nevertheless appears that a constant ratio of length to deflection angle should result in a more uniform and possibly better test method. A constant ratio of length to deflection angle produces a reasonably uniform curvature in the specimen regardless of the length tested. If a ratio of 1 to 5 is used, the curvature seems reasonable with a radius of about 5.7 cm., and furthermore it provides a simple, easily remembered procedure for determining the proper test angle for any given length, in convenient scale divisions for each of the stiffness testers. The restriction of certain angles to certain lengths, of course, tends to limit the test range of any one instrument, but by having a choice of many different widths available, this is not too serious.

Tables in some form materially lessen the time required for calculation of test values. The original stiffness formula

$$S = \frac{ML^{0.8}}{3b\theta}$$

in which

M = C (calibration constant) $\times$ F (torque scale reading in degrees)
L = test length in centimeters
b = test width in centimeters
θ = D (deflection scale reading in degrees) $\div$ 57.3 (to convert to radians)

may be rearranged as follows:

$$S = \frac{F(CL^{0.8})}{3b\theta}$$

The following tables, for example, may be prepared for each tester:

(1) $CL^{0.8}$ for various lengths L. (2) $3b\theta$ for various widths b and deflection angles D. Then the stiffness value S can be conveniently calculated from the torque scale reading F by the use of numbers taken from the two tables.

CONCLUSION

The three model stiffness testers described in this paper provide suitable means for determining the inherent stiffness of a very large group of materials.

The dual-range instrument is near the optimum upper limit, inasmuch as the special advantages offered by the design of these particular testers are most evident when testing the more flexible materials.

The ultra-low-range model seems, in turn, to be nearing the lower practical limit because difficulties both of construction and use increase very rapidly if the range is extended much lower.

LITERATURE CITED

1. Carson, F. T., and Worthington, Vernon, *Tappi* 36: 36 (Jan., 1953).

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Predicting the Brightness of Groundwood-Sulphite Pulp Mixtures

D. J. MacLAURIN and F. A. AFLENZER

Spruce groundwood and sulphite pulps were each bleached to several brightness levels with sodium peroxide and calcium hypochlorite, respectively. The brightnesses of an array of mixtures of these two series were measured and calculated. The measured and calculated values were in very good agreement. Thus, it appears that the brightness of any multipulp mixture can be predicted by calculation when the brightnesses of the components are known. When unit bleaching costs of the components are known, it is therefore possible to calculate the optimum brightness for each component to give a minimum over-all bleaching cost for a given brightness of a mixture.

Brightness is an important property of many sheets. Therefore, in considering sheets to contain two or more pulps, it is useful to be able to predict this sheet property for various mixtures of the pulps over a range of brightness for each pulp. Through such prediction may be estimated various brightness-cost relationships. These predictions for all combinations may be made through measurements of certain optical properties on sheets of each pulp alone. While the illustrative experimental data in this study are for groundwood-sulphite mixtures, the principles discussed are generally applicable and readily adaptable to other pulp mixtures. Let it be recalled that light falling on a sheet of paper may be reflected, absorbed, and transmitted. The distribution of the incident light among these three determines the optical properties of the sheet.

In this study, and in accordance with general usage, the brightness of a sheet of paper is defined as the percentage of incident light which is reflected, when measured by an instrument and procedures conforming to the requirements of TAPPI Standard T 452 m-48, using a narrow band of the spectrum with an effective wavelength of 457 ±0.5 mmu. The Kubelka-Munk (*1*) theory deals with the scattering and absorption of light as it passes through a continuous medium. Steele (*2*, *3*) adapted this general theory to considerations of the optical properties of paper. The theory provides the following relationships:

$$R_\infty = 1 + k/s - \sqrt{(k/s)^2 + 2(k/s)} \qquad (1)$$

or

$$k/s = (1 - R_\infty)^2/2R_\infty \qquad (2)$$

$$R_0 = \frac{e^{sW}(1/R_\infty - R_\infty) - 1}{1/R_\infty \cdot e^{sW}(1/R_\infty - R_\infty) - R_\infty} \qquad (3)$$

where

R_∞ = the reflectance of a sheet, or pile of sheets, of thickness sufficient to prevent transmission of any of the incident light; it is a ratio, and hence dimensionless; when R_∞ is measured in the manner and by the apparatus defined in TAPPI Standard T 452 m-48, the value obtained is the "brightness" of the sheet

R_0 = the reflectance of a sheet when backed by a surface of no reflectance; it is a ratio, and hence dimensionless

k = the specific absorption coefficient

s = the specific scattering coefficient (both of these coefficients are expressed in reciprocal basis weight units as discussed by Van den Akker (*4*); in this study the units will be square centimeters per gram

W = the basis weight; in this study, the units will be grams per square centimeter

As will be shown, a prediction of the brightness of sheets to contain any mixture of pulps can be made from measured values of R_∞, R_0, and the basis weight of sheets of each pulp. From equation (1) it is seen that R_∞ is dependent on both the scattering and absorbing properties of the sheet and nothing else. From equation (3) it is seen that R_0 depends not only on the scattering and absorbing properties, but also upon the basis weight of the sheet.

In a sheet, scattering is mainly dependent on the kind and amount of the optical interfaces it contains. Thus, for a given pulp, both the refining it has undergone and the density of sheets made from it affect the scattering it will cause in a sheet. Absorption is largely independent of these factors, being affected only by changes in the composition of the pulp. Thus, in preparing handsheets for measurement of R_∞ and R_0 and basis weight, for predicting the brightness of mixtures, the degree of refining of the pulp and the handsheet density and basis weight must be considered. Each pulp should be refined to about the level at which it will be used. Handsheet pressing should be standardized to give sheet densities similar to those of the sheets in which the pulp will be used. Handsheet basis weight should also agree with that of the final sheet. As a rule, in a sheet made from two or more pulps, each pulp may be considered to act independently with respect to scattering and absorption of incident light. In such cases the scattering and absorption coefficients of the individual pulp sheets are additive and are related to those of the mixed pulp sheet as follows:

$$s_{\text{sheet}} = [s_A(\%A) + s_B(\%B)]/100 \qquad (4)$$

$$k_{\text{sheet}} = [k_A(\%A) + k_B(\%B)]/100 \qquad (5)$$

Thus, it becomes apparent that if the s and k can be determined for each pulp, the s and k for the sheet can be calculated and hence, through equations (1) and (2), the brightness of the sheet (R_∞) can also be calculated. By measuring R_∞ and R_0 for each pulp, s and k for each pulp may be calculated by simultaneous solution of equations (1) and (3). Fortunately such

D. J. MacLaurin, Research Associate, The Institute of Paper Chemistry, Appleton, Wis., and F. A. Aflenzer, Institut für Papier- und Zellstofftechnik, Technische Hochschule, Graz, Austria.

Table I. R_∞ versus k/s for Absolute Values of R_∞ from 0.0 to 1.000

R_∞	k/s	R_∞	k/s	R_∞	k/s	R_∞	k/s	R_∞	k/s
0.000	∞	0.084	4.99438	0.168	2.06019	0.252	1.11013	0.336	0.65610
0.001	449.00050	0.085	4.92485	0.169	2.04308	0.253	1.10278	0.337	0.65218
0.002	249.00100	0.086	4.85695	0.170	2.02618	0.254	1.09550	0.338	0.64829
0.003	165.66817	0.087	4.79063	0.171	2.00948	0.255	1.08828	0.339	0.64443
0.004	124.00200	0.088	4.72582	0.172	1.99297	0.256	1.08113	0.340	0.64059
0.005	99.00250	0.089	4.66248	0.173	1.97667	0.257	1.07403	0.341	0.63678
0.006	82.33633	0.090	4.60056	0.174	1.96056	0.258	1.06698	0.342	0.63299
0.007	70.43207	0.091	4.54001	0.175	1.94464	0.259	1.06000	0.343	0.62923
0.008	61.50400	0.092	4.48078	0.176	1.92891	0.260	1.05308	0.344	0.62549
0.009	54.56056	0.093	4.42284	0.177	1.91336	0.261	1.04621	0.345	0.62178
0.010	49.00500	0.094	4.36615	0.178	1.89799	0.262	1.03940	0.346	0.61809
0.011	44.46005	0.095	4.31066	0.179	1.88280	0.263	1.03264	0.347	0.61442
0.012	40.67267	0.096	4.25633	0.180	1.86778	0.264	1.02594	0.348	0.61078
0.013	37.46804	0.097	4.20314	0.181	1.85293	0.265	1.01929	0.349	0.60716
0.014	34.72000	0.098	4.15104	0.182	1.83825	0.266	1.01270	0.350	0.60357
0.015	32.34083	0.099	4.10001	0.183	1.82374	0.267	1.00616	0.351	0.60000
0.016	30.25800	0.100	4.05000	0.184	1.80939	0.268	0.99967	0.352	0.59645
0.017	28.42026	0.101	4.00100	0.185	1.79520	0.269	0.99326	0.353	0.59293
0.018	26.78676	0.102	3.95296	0.186	1.78117	0.270	0.98685	0.354	0.58943
0.019	25.32529	0.103	3.90587	0.187	1.76730	0.271	0.98052	0.355	0.58595
0.020	24.01000	0.104	3.85969	0.188	1.75357	0.272	0.97424	0.356	0.58249
0.021	22.82002	0.105	3.81440	0.189	1.74000	0.273	0.96800	0.357	0.57906
0.022	21.73827	0.106	3.76998	0.190	1.72658	0.274	0.96182	0.358	0.57565
0.023	20.75063	0.107	3.71806	0.191	1.71330	0.275	0.95568	0.359	0.57226
0.024	19.84533	0.108	3.68363	0.192	1.70017	0.276	0.94959	0.360	0.56889
0.025	19.01250	0.109	3.64166	0.193	1.68717	0.277	0.94355	0.361	0.56554
0.026	18.24377	0.110	3.60045	0.194	1.67432	0.278	0.93756	0.362	0.56222
0.027	17.53202	0.111	3.56000	0.195	1.66160	0.279	0.93161	0.363	0.55891
0.028	16.87114	0.112	3.52029	0.196	1.64902	0.280	0.92572	0.364	0.55563
0.029	16.25588	0.113	3.48128	0.197	1.63657	0.281	0.91986	0.365	0.55236
0.030	15.68167	0.114	3.44296	0.198	1.62425	0.282	0.91405	0.366	0.54912
0.031	15.14453	0.115	3.40533	0.199	1.61206	0.283	0.90828	0.367	0.54590
0.032	14.64100	0.116	3.36834	0.200	1.60000	0.284	0.90256	0.368	0.54270
0.033	14.16802	0.117	3.33200	0.201	1.58806	0.285	0.89689	0.369	0.53951
0.034	13.72288	0.118	3.29629	0.202	1.57627	0.286	0.89125	0.370	0.53635
0.035	13.30321	0.119	3.26118	0.203	1.56455	0.287	0.88566	0.371	0.53321
0.036	12.90689	0.120	3.22667	0.204	1.55298	0.288	0.88011	0.372	0.53009
0.037	12.53201	0.121	3.19273	0.205	1.54152	0.289	0.87460	0.373	0.52698
0.038	12.17689	0.122	3.15936	0.206	1.53018	0.290	0.86914	0.374	0.52390
0.039	11.84001	0.123	3.12654	0.207	1.51896	0.291	0.86371	0.375	0.52083
0.040	11.52000	0.124	3.09426	0.208	1.50785	0.292	0.85833	0.376	0.51779
0.041	11.21562	0.125	3.06250	0.209	1.49684	0.293	0.85298	0.377	0.51476
0.042	10.92576	0.126	3.03125	0.210	1.48595	0.294	0.84768	0.378	0.51175
0.043	10.64941	0.127	3.00051	0.211	1.47517	0.295	0.84242	0.379	0.50876
0.044	10.38564	0.128	2.97025	0.212	1.46449	0.296	0.83719	0.380	0.50579
0.045	10.13361	0.129	2.94047	0.213	1.45392	0.297	0.83200	0.381	0.50284
0.046	9.89256	0.130	2.91115	0.214	1.44345	0.298	0.82685	0.382	0.49990
0.047	9.66180	0.131	2.88229	0.215	1.43308	0.299	0.82174	0.383	0.49698
0.048	9.44067	0.132	2.85388	0.216	1.42281	0.300	0.81667	0.384	0.49408
0.049	9.22858	0.133	2.82590	0.217	1.41265	0.301	0.81163	0.385	0.49120
0.050	9.02500	0.134	2.79834	0.218	1.40258	0.302	0.80663	0.386	0.48834
0.051	8.82942	0.135	2.77120	0.219	1.39261	0.303	0.80167	0.387	0.48549
0.052	8.64138	0.136	2.74447	0.220	1.38274	0.304	0.79674	0.388	0.48266
0.053	8.46046	0.137	2.71814	0.221	1.37294	0.305	0.79184	0.389	0.47985
0.054	8.28626	0.138	2.69219	0.222	1.36325	0.306	0.78699	0.390	0.47705
0.055	8.11841	0.139	2.66662	0.223	1.35365	0.307	0.78216	0.391	0.47427
0.056	7.95657	0.140	2.64143	0.224	1.34414	0.308	0.77738	0.392	0.47151
0.057	7.80043	0.141	2.61660	0.225	1.33472	0.309	0.77262	0.393	0.46876
0.058	7.64969	0.142	2.59213	0.226	1.32539	0.310	0.76790	0.394	0.46604
0.059	7.51255	0.143	2.56800	0.227	1.31614	0.311	0.76322	0.395	0.46332
0.060	7.36333	0.144	2.54422	0.228	1.30698	0.312	0.75856	0.396	0.46063
0.061	7.22722	0.145	2.52078	0.229	1.29791	0.313	0.75394	0.397	0.45795
0.062	7.09552	0.146	2.49766	0.230	1.28891	0.314	0.74936	0.398	0.45528
0.063	6.96801	0.147	2.47486	0.231	1.28000	0.315	0.74480	0.399	0.45263
0.064	6.84450	0.148	2.45238	0.232	1.27117	0.316	0.74028	0.400	0.45000
0.065	6.72481	0.149	2.43020	0.233	1.26242	0.317	0.73579	0.401	0.44738
0.066	6.60876	0.150	2.40833	0.234	1.25375	0.318	0.73133	0.402	0.44478
0.067	6.49619	0.151	2.38676	0.235	1.24516	0.319	0.72690	0.403	0.44219
0.068	6.38694	0.152	2.36547	0.236	1.23664	0.320	0.72250	0.404	0.43962
0.069	6.28088	0.153	2.34447	0.237	1.22820	0.321	0.71813	0.405	0.43707
0.070	6.17786	0.154	2.32375	0.238	1.21984	0.322	0.71380	0.406	0.43453
0.071	6.07775	0.155	2.30331	0.239	1.21155	0.323	0.70949	0.407	0.43200
0.072	5.98044	0.156	2.28313	0.240	1.20333	0.324	0.70521	0.408	0.42949
0.073	5.88582	0.157	2.26321	0.241	1.19519	0.325	0.70096	0.409	0.42699
0.074	5.79376	0.158	2.24356	0.242	1.18712	0.326	0.69674	0.410	0.42451
0.075	5.70417	0.159	2.22415	0.243	1.17911	0.327	0.69255	0.411	0.42205
0.076	5.61695	0.160	2.20500	0.244	1.17118	0.328	0.68839	0.412	0.41959
0.077	5.53201	0.161	2.18609	0.245	1.16332	0.329	0.68426	0.413	0.41715
0.078	5.44926	0.162	2.16742	0.246	1.15552	0.330	0.68015	0.414	0.41473
0.079	5.36861	0.163	2.14898	0.247	1.14779	0.331	0.67607	0.415	0.41232
0.080	5.29000	0.164	2.13078	0.248	1.14013	0.332	0.67202	0.416	0.40992
0.081	5.21334	0.165	2.11280	0.249	1.13253	0.333	0.66800	0.417	0.40754
0.082	5.13856	0.166	2.09505	0.250	1.12500	0.334	0.66401	0.418	0.40517
0.083	5.06560	0.167	2.07751	0.251	1.11753	0.335	0.66004	0.419	0.40282

Table I. R_∞ versus k/s for Absolute Values of R_∞ from 0.0 to 1.000 (*Continued*)

R_∞	k/s	R_∞	k/s	R_∞	k/s	R_∞	k/s	R_∞	k/s
0.420	0.40048	0.504	0.24406	0.588	0.14434	0.672	0.08005	0.756	0.03938
0.421	0.39815	0.505	0.24260	0.589	0.14340	0.673	0.07944	0.757	0.03900
0.422	0.39583	0.506	0.24114	0.590	0.14246	0.674	0.07884	0.758	0.03863
0.423	0.39353	0.507	0.23969	0.591	0.14152	0.675	0.07824	0.759	0.03826
0.424	0.39125	0.508	0.23825	0.592	0.14059	0.676	0.07764	0.760	0.03789
0.425	0.38897	0.509	0.23682	0.593	0.13967	0.677	0.07705	0.761	0.03753
0.426	0.38671	0.510	0.23539	0.594	0.13875	0.678	0.07646	0.762	0.03717
0.427	0.38446	0.511	0.23397	0.595	0.13784	0.679	0.07588	0.763	0.03681
0.428	0.38222	0.512	0.23256	0.596	0.13693	0.680	0.07529	0.764	0.03645
0.429	0.38000	0.513	0.23116	0.597	0.13602	0.681	0.07471	0.765	0.03609
0.430	0.37779	0.514	0.22976	0.598	0.13512	0.682	0.07414	0.766	0.03574
0.431	0.37559	0.515	0.22837	0.599	0.13422	0.683	0.07356	0.767	0.03539
0.432	0.37341	0.516	0.22699	0.600	0.13333	0.684	0.07299	0.768	0.03504
0.433	0.37123	0.517	0.22562	0.601	0.13245	0.685	0.07243	0.769	0.03470
0.434	0.36907	0.518	0.22425	0.602	0.13156	0.686	0.07186	0.770	0.03435
0.435	0.36693	0.519	0.22289	0.603	0.13069	0.687	0.07130	0.771	0.03401
0.436	0.36479	0.520	0.22154	0.604	0.12981	0.688	0.07074	0.772	0.03367
0.437	0.36266	0.521	0.22019	0.605	0.12895	0.689	0.07019	0.773	0.03333
0.438	0.36055	0.522	0.21885	0.606	0.12808	0.690	0.06964	0.774	0.03299
0.439	0.35845	0.523	0.21752	0.607	0.12722	0.691	0.06909	0.775	0.03266
0.440	0.35636	0.524	0.21620	0.608	0.12637	0.692	0.06854	0.776	0.03233
0.441	0.35429	0.525	0.21488	0.609	0.12552	0.693	0.06800	0.777	0.03200
0.442	0.35222	0.526	0.21357	0.610	0.12467	0.694	0.06746	0.778	0.03167
0.443	0.35017	0.527	0.21227	0.611	0.12383	0.695	0.06692	0.779	0.03135
0.444	0.34813	0.528	0.21097	0.612	0.12299	0.696	0.06639	0.780	0.03103
0.445	0.34610	0.529	0.20968	0.613	0.12216	0.697	0.06586	0.781	0.03070
0.446	0.34408	0.530	0.20840	0.614	0.12133	0.698	0.06533	0.782	0.03039
0.447	0.34207	0.531	0.20712	0.615	0.12051	0.699	0.06481	0.783	0.03007
0.448	0.34007	0.532	0.20585	0.616	0.11969	0.700	0.06429	0.784	0.02976
0.449	0.33809	0.533	0.20459	0.617	0.11887	0.701	0.06377	0.785	0.02944
0.450	0.33611	0.534	0.20333	0.618	0.11806	0.702	0.06325	0.786	0.02913
0.451	0.33413	0.535	0.20208	0.619	0.11725	0.703	0.06274	0.787	0.02882
0.452	0.33219	0.536	0.20084	0.620	0.11645	0.704	0.06223	0.788	0.02852
0.453	0.33025	0.537	0.19960	0.621	0.11565	0.705	0.06172	0.789	0.02821
0.454	0.32832	0.538	0.19837	0.622	0.11486	0.706	0.06122	0.790	0.02791
0.455	0.32640	0.539	0.19714	0.623	0.11407	0.707	0.06071	0.791	0.02761
0.456	0.32449	0.540	0.19593	0.624	0.11328	0.708	0.06021	0.792	0.02731
0.457	0.32259	0.541	0.19471	0.625	0.11250	0.709	0.05972	0.793	0.02702
0.458	0.32070	0.542	0.19351	0.626	0.11172	0.710	0.05923	0.794	0.02672
0.459	0.31882	0.543	0.19231	0.627	0.11095	0.711	0.05873	0.795	0.02643
0.460	0.31696	0.544	0.19112	0.628	0.11018	0.712	0.05825	0.796	0.02614
0.461	0.31510	0.545	0.18993	0.629	0.10941	0.713	0.05776	0.797	0.02585
0.462	0.31325	0.546	0.18875	0.630	0.10865	0.714	0.05728	0.798	0.02557
0.463	0.31141	0.547	0.18758	0.631	0.10789	0.715	0.05680	0.799	0.02528
0.464	0.30959	0.548	0.18641	0.632	0.10714	0.716	0.05632	0.800	0.02500
0.465	0.30777	0.549	0.18525	0.633	0.10639	0.717	0.05585	0.801	0.02472
0.466	0.30596	0.550	0.18409	0.634	0.10564	0.718	0.05538	0.802	0.02444
0.467	0.30416	0.551	0.18294	0.635	0.10490	0.719	0.05491	0.803	0.02417
0.468	0.30238	0.552	0.18180	0.636	0.10416	0.720	0.05444	0.804	0.02389
0.469	0.30060	0.553	0.18066	0.637	0.10343	0.721	0.05398	0.805	0.02362
0.470	0.29883	0.554	0.17953	0.638	0.10270	0.722	0.05352	0.806	0.02335
0.471	0.29707	0.555	0.17840	0.639	0.10197	0.723	0.05306	0.807	0.02308
0.472	0.29532	0.556	0.17728	0.640	0.10125	0.724	0.05261	0.808	0.02281
0.473	0.29358	0.557	0.17617	0.641	0.10053	0.725	0.05216	0.809	0.02255
0.474	0.29185	0.558	0.17506	0.642	0.09982	0.726	0.05171	0.810	0.02228
0.475	0.29013	0.559	0.17396	0.643	0.09910	0.727	0.05126	0.811	0.02202
0.476	0.28842	0.560	0.17286	0.644	0.09840	0.728	0.05081	0.812	0.02176
0.477	0.28672	0.561	0.17177	0.645	0.08769	0.729	0.05037	0.813	0.02151
0.478	0.28503	0.562	0.17068	0.646	0.09699	0.730	0.04993	0.814	0.02125
0.479	0.28334	0.563	0.16960	0.647	0.09630	0.731	0.04949	0.815	0.02100
0.480	0.28167	0.564	0.16852	0.648	0.09560	0.732	0.04906	0.816	0.02075
0.481	0.28000	0.565	0.16746	0.649	0.09492	0.733	0.04863	0.817	0.02050
0.482	0.27834	0.566	0.16639	0.650	0.09423	0.734	0.04820	0.818	0.02025
0.483	0.27670	0.567	0.16533	0.651	0.09355	0.735	0.04777	0.819	0.02000
0.484	0.27506	0.568	0.16428	0.652	0.09287	0.736	0.04735	0.820	0.01976
0.485	0.27343	0.569	0.16323	0.653	0.09220	0.737	0.04693	0.821	0.01951
0.486	0.27181	0.570	0.16219	0.654	0.09153	0.738	0.04651	0.822	0.01927
0.487	0.27019	0.571	0.16116	0.655	0.09086	0.739	0.04609	0.823	0.01903
0.488	0.26859	0.572	0.16013	0.656	0.09020	0.740	0.04568	0.824	0.01880
0.489	0.26699	0.573	0.15910	0.657	0.08954	0.741	0.04526	0.825	0.01856
0.490	0.26541	0.574	0.15808	0.658	0.08888	0.742	0.04585	0.826	0.01833
0.491	0.26383	0.575	0.15707	0.659	0.08823	0.743	0.04445	0.827	0.01809
0.492	0.26226	0.576	0.15606	0.660	0.08758	0.744	0.04404	0.828	0.01786
0.493	0.26070	0.577	0.15505	0.661	0.08693	0.745	0.04364	0.829	0.01764
0.494	0.25915	0.578	0.15405	0.662	0.08629	0.746	0.04324	0.830	0.01741
0.495	0.25760	0.579	0.15306	0.663	0.08565	0.747	0.04284	0.831	0.01718
0.496	0.25606	0.580	0.15207	0.664	0.08501	0.748	0.04245	0.832	0.01698
0.497	0.25454	0.581	0.15109	0.665	0.08438	0.749	0.04206	0.833	0.01674
0.498	0.25302	0.582	0.15011	0.666	0.08375	0.750	0.04167	0.834	0.01652
0.499	0.25150	0.583	0.14913	0.667	0.08313	0.751	0.04128	0.835	0.01630
0.500	0.25000	0.584	0.14816	0.668	0.08250	0.752	0.04089	0.836	0.01609
0.501	0.24850	0.585	0.14720	0.669	0.08188	0.753	0.04051	0.837	0.01587
0.502	0.24702	0.586	0.14624	0.670	0.08127	0.754	0.04013	0.838	0.01566
0.503	0.24554	0.587	0.14529	0.671	0.08066	0.755	0.03975	0.839	0.01545

Table I. R_∞ versus k/s for Absolute Values of R_∞ from 0.0 to 1.000 (*Continued*)

R∞	k/s	R∞	k/s	R∞	k/s	R∞	k/s	R∞	k/s
0.840	0.01524	0.873	0.00924	0.906	0.00488	0.939	0.00198	0.972	0.00040
0.841	0.01503	0.874	0.00908	0.907	0.00477	0.940	0.00191	0.973	0.00037
0.842	0.01482	0.875	0.00893	0.908	0.00466	0.941	0.00185	0.974	0.00035
0.843	0.01462	0.876	0.00878	0.909	0.00456	0.942	0.00179	0.975	0.00032
0.844	0.01442	0.877	0.00863	0.910	0.00445	0.943	0.00172	0.976	0.00030
0.845	0.01422	0.878	0.00848	0.911	0.00435	0.944	0.00166	0.977	0.00027
0.846	0.01402	0.879	0.00833	0.912	0.00425	0.945	0.00160	0.978	0.00025
0.847	0.01382	0.880	0.00818	0.913	0.00415	0.946	0.00154	0.979	0.00023
0.848	0.01362	0.881	0.00804	0.914	0.00405	0.947	0.00148	0.980	0.00020
0.849	0.01343	0.882	0.00789	0.915	0.00395	0.948	0.00143	0.981	0.00018
0.850	0.01324	0.883	0.00775	0.916	0.00385	0.949	0.00137	0.982	0.00016
0.851	0.01304	0.884	0.00759	0.917	0.00376	0.950	0.00132	0.983	0.00015
0.852	0.01285	0.885	0.00747	0.918	0.00366	0.951	0.00126	0.984	0.00013
0.853	0.01267	0.886	0.00733	0.919	0.00357	0.952	0.00121	0.985	0.00011
0.854	0.01248	0.887	0.00720	0.920	0.00348	0.953	0.00116	0.986	0.00010
0.855	0.01230	0.888	0.00706	0.921	0.00339	0.954	0.00111	0.987	0.00009
0.856	0.01211	0.889	0.00693	0.922	0.00330	0.955	0.00106	0.988	0.00007
0.857	0.01193	0.890	0.00680	0.923	0.00321	0.956	0.00101	0.989	0.00006
0.858	0.01175	0.891	0.00667	0.924	0.00313	0.957	0.00097	0.990	0.00005
0.859	0.01157	0.892	0.00654	0.925	0.00304	0.958	0.00092	0.991	0.00004
0.860	0.01140	0.893	0.00641	0.926	0.00296	0.959	0.00088	0.992	0.00003
0.861	0.01122	0.894	0.00628	0.927	0.00287	0.960	0.00083	0.993	0.00002
0.862	0.01105	0.895	0.00616	0.928	0.00279	0.961	0.00079	0.994	0.00002
0.863	0.01087	0.896	0.00604	0.929	0.00271	0.962	0.00075	0.995	0.00001
0.864	0.01070	0.897	0.00591	0.930	0.00263	0.963	0.00071	0.996	0.00001
0.865	0.01054	0.898	0.00579	0.931	0.00256	0.964	0.00067	0.997	0.00000
0.866	0.01036	0.899	0.00567	0.932	0.00248	0.965	0.00063	0.998	0.00000
0.867	0.01020	0.900	0.00555	0.933	0.00241	0.966	0.00060	0.999	0.00000
0.868	0.01004	0.901	0.00544	0.934	0.00233	0.967	0.00056	1.000	0.00000
0.869	0.00987	0.902	0.00532	0.935	0.00226	0.968	0.00053		
0.870	0.00971	0.903	0.00521	0.936	0.00219	0.969	0.00050		
0.871	0.00955	0.904	0.00510	0.937	0.00212	0.970	0.00046		
0.872	0.00939	0.905	0.00499	0.938	0.00205	0.971	0.00043		

lengthy calculations are avoided through the use of the familiar chart prepared by Judd (*5*, *6*) which is available as TAPPI Data Sheet 65. In using this chart an SX value is read from the intersection of the appropriate R_0 and R_∞ lines. This value is numerically equal to sW and hence s is calculated from the relationship

$$s = \frac{SX}{W} \qquad (6)$$

Now k may be calculated from equation (2). Foote (*7*) has provided a table relating R_∞ to k/s, over the brightness range 20 to 90, which greatly simplifies this calculation. The complete table of values of R_∞ versus k/s based upon calculations by Foote is given in Table I and is expected to be issued as TAPPI Data Sheet 65A. Thus, the k and s for each pulp are determined and summed on a weighted basis to give the k and s of the sheet, from which the brightness of the sheet is obtained. Further useful charts and tables relating these and other optical properties are given by Steele (*2*, *3*), Giertz (*8*), and Campbell and Benny (*9*).

The procedure detailed above is rigorous providing the requirements of the Kubelka-Munk theory are satisfied, which they normally are in uncoated sheets. Coated sheets, calendered-dyed sheets, and other nonhomogeneous sheets require consideration of additional factors for application of the theory and hence may give misleading data when treated by this procedure.

Foote (*7*) has demonstrated that when the s values of the component pulps are of the same order, the following empirical relationship is remarkably accurate:

$$(k/s)_{\text{sheet}} = [\%A(k/s)_A] + [\%B(k/s)_B]/100 \qquad (7)$$

This equation, used in conjunction with Table I (or TAPPI Data Sheet 65A) provides a useful and simple way of predicting the brightness of pulp mixtures. The same cautions on refining and pressing apply here.

Table II. Optical Data for Sheets of Individual Pulps

Bleaching chemical, % applied	*Basis weight, g./sq. cm.*	R∞	R0	k/s	sW	s	k
			Groundwood				
As Na_2O_2							
0.0	0.00388	59.5	57.3	0.13784	2.60	670	92.4
1.0	0.00395	62.5	60.0	0.11250	2.80	709	79.8
1.5	0.00390	66.5	63.1	0.08438	2.88	738	62.3
2.0	0.00410	70.1	67.2	0.06377	3.50	854	54.5
2.5	0.00395	76.0	72.8	0.03789	4.60	1165	44.1
			Sulphite				
As Cl_2							
0.0	0.00393	60.3	57.7	0.13069	2.55	649	84.8
2.3	0.00400	65.3	62.6	0.09220	3.00	750	69.2
3.7	0.00402	70.1	67.0	0.06377	3.40	846	53.9
4.7	0.00390	75.2	70.8	0.04089	3.60	923	37.7
6.0	0.00390	80.5	73.9	0.02362	3.65	936	22.1
8.0	0.00390	85.1	76.1	0.01304	3.67	941	12.3

Table III. Optical Data for Pulp Mixtures

Groundwood pulp, %	*Sulphite pulp, %*	R_∞ *(obs.)*	R_∞ *(calc.) eq. 1–2*	R_∞ *(calc.) eq. 7*	R_0 *(obs.)*	*Basis weight, g./sq. cm.*	s	k
100	..	59.5	..	..	57.3	0.00388	670	92.4
80	20	61.9	62.4	63.0	59.5	0.00395	721	81.4
60	40	64.4	65.4	64.3	61.9	0.00402	771	70.5
50	50	66.4	66.9	65.7	63.6	0.00392	797	65.0
40	60	68.4	68.5	67.2	65.4	0.00394	822	59.6
20	80	71.3	71.7	70.8	67.6	0.00392	872	48.7
..	100	75.2	..	..	70.8	0.00390	923	37.7
100	..	70.1	..	..	67.6	0.00394	939	59.9
80	20	71.0	71.0	..	68.2	0.00390	936	55.4
60	40	72.0	71.9	..	68.8	0.00388	932	51.0
50	50	72.6	72.5	..	69.2	0.00393	932	48.8
40	60	72.8	72.9	..	69.5	0.00389	930	46.6
20	80	74.0	74.0	..	70.2	0.00389	926	42.2
..	100	75.2	..	..	70.8	0.00390	923	37.7
100	..	59.5	..	..	57.3	0.00388	670	92.4
80	20	63.3	63.4	62.8	61.6	0.00395	724	76.4
60	40	67.2	67.6	65.8	63.7	0.00398	778	60.3
50	50	69.7	69.8	68.0	66.0	0.00395	805	52.4
40	60	72.1	72.2	70.3	67.9	0.00397	833	44.4
20	80	77.3	77.7	76.3	71.7	0.00394	887	28.3
..	100	85.1	..	..	76.1	0.00390	941	12.3

EXPERIMENTAL

A series of bleached spruce groundwood pulps was prepared using sodium peroxide in the conventional way. A second series was prepared from spruce sulphite using calcium hypochlorite. Handsheets of the individual pulps and mixtures of them were made on a rapid Köthen sheet machine, which is quite similar to the TAPPI standard sheet machine. The suspension in the sheet-mold deckle cylinder was adjusted to about 0.02% consistency and stirred with pressure water for 5 sec. The sheet was drained at low vacuum. The wire was covered with a fine mesh rayon cloth and the grid supporting the wire was removed. These techniques gave good sheet formation and retention. The rayon cloth made it possible to couch the groundwood sheets with considerably less difficulty than was found on the wire alone. The handsheets were couched onto a smooth filter paper. The rayon was carefully peeled off and replaced with a smooth filter paper. The handsheets were kept between the filters and pressed between blotters in stacks of six for 5 min. at 50 p.s.i. The sheets were dried without restraint between the filters for 4 hr. at 73°F. and 50% R.H., and then pressed for 1 min. at 20 p.s.i. The R_∞ and R_0 of the sheets was measured on a G.E. reflection meter in accordance with TAPPI Standard T 452 m-48.

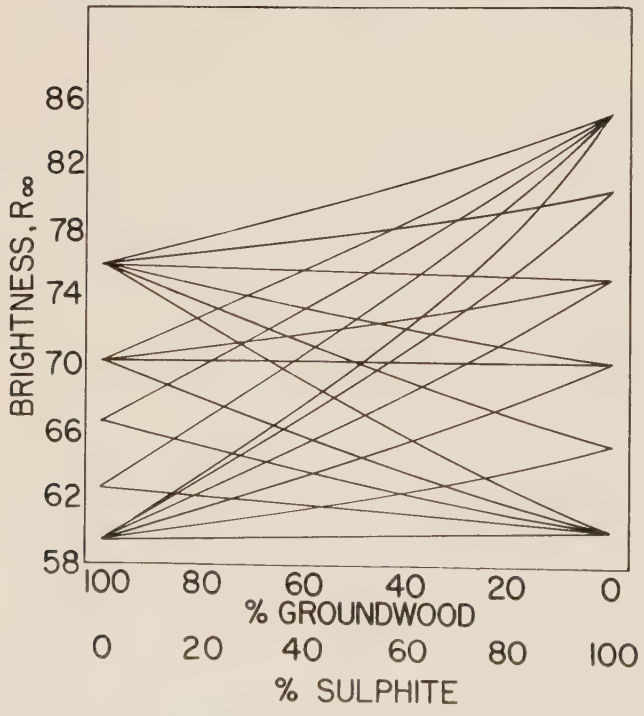

Fig. 1. Brightness of mixtures

RESULTS AND DISCUSSION

The optical data for sheets of the individual pulps are given in Table II. In Table III are given observed and calculated data for three pairs of the pulps of Table II at various mixture ratios. The agreement between the observed and calculated values is considered useful, and good support of the contention that prediction of brightness can be made as discussed. Using these procedures, a chart of the type shown in Fig. 1 may be constructed for brightness, using calculated values. From such a chart the brightness of any mixture may be read either directly or by interpolation. Table IV shows observed and calculated brightnesses for five different 40/60 groundwood-sulphite mixtures. Such an array can be set up from the chart in Fig. 1, and it can be used to estimate bleaching costs to a given brightness level for a given furnish, or to predict the effect of different brightness combinations.

Thus, brightness of mixed pulp furnishes may be predicted from values of R_∞, R_0, and the basis weight of suitable handsheets made from each pulp separately

Table IV. Some 40/60 Groundwood-Sulphite Mixtures to give 70% Brightness

40% groundwood plus 60% sulphite					
G.E. brightness, %	Na_2O_2, %	*G.E. brightness, %*	Cl_2, %	*Brightness of mixture, % G.E. Measured*	*Calculated*
59.5	0.0	80.5	6.0	70.2	70.8
62.5	1.0	75.2	4.7	69.8	69.8
66.5	1.5	75.2	4.7	71.4	71.6
70.1	2.0	70.1	3.7	70.1	70.1
76.0	2.5	65.3	2.3	69.7	70.0

at several brightnesses. It should be noted that the brightness of a given sheet is intimately connected with not only the pulps and the other components of the furnish, but also the whole stock preparation and papermaking sequence, and hence, while brightness predictions made on a handsheet basis are useful as first approximations of final commercial values, they are much more useful for establishing trends and comparison.

LITERATURE CITED

1. Kubelka, P., and Munk, F., *Z. tech. Physik.* 12: 593–601 (1931).
2. Steele, F. A., *Paper Trade J.* 100, No. 12: 37–42 (March 21, 1935); *Tech. Assoc. Papers* 18: 299–304 (June, 1935).
3. Steele, F. A., *Paper Trade J.* 104, No. 8: 157–158 (Feb. 25 1937); *Tech. Assoc. Papers* 20: 37–39, 151–152 (June, 1937).
4. Van den Akker, J. A., *Tappi* 32, No. 11: 498–501 (Nov., 1949).
5. Judd, D. B., *Paper Trade J.* 100, No. 1: 28–32 (Jan. 3, 1935); *Tech. Assoc. Papers* 18: 441–442 (June, 1935).
6. Judd, D. B., *Paper Trade J.* 106, No. 1: 39–46 (Jan. 6, 1938); *Tech. Assoc. Papers* 21: 474–481 (June, 1938).
7. Foote, W. J., *Paper Trade J.* 122, No. 8: 35–37 (Feb. 21, 1946); *Tech. Assoc. Papers* 29: 180–182 (June, 1946).
8. Giertz, H. W., *Svensk Papperstidn.* 53, No. 21: 673–680 (Nov. 15, 1950).
9. Campbell, W. B., and Benny, J., *Pulp Paper Mag. Can.* 47, No. 7: 74–78 (June, 1946).

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An Orienting Study of the Effect of the Neutral Sulphite Semichemical Cook on the Hemicelluloses of Aspenwood

DAVID C. LEA

Three neutral sulphite semichemical (NSSC) cooks were made of aspenwood chips. Yields of the cooks were approximately 75%. Holocelluloses were prepared from the original aspenwood and from an NSSC pulp. Hemicelluloses were extracted with 5% followed by 16% potassium hydroxide from the holocelluloses, the NSSC pulp, and the original aspenwood. Hemicelluloses were also recovered from the spent liquors of the cooks. The hemicelluloses, holocelluloses, pulp, original aspenwood, and residues left after extraction were analyzed for ash, Klason lignin, "apparent lignin" not determinable by the Klason procedure as indicated by ultraviolet absorption data, pentosans, uronic anhydride, and sugars present and amounts of each. The sugar analyses were made by chromatographic techniques. In addition, the intrinsic viscosities (in 10% potassium hydroxide) were determined for the hemicelluloses. The experimental data indicate that under NSSC cooking conditions used in this study: (1) One third of the hemicelluloses are removed from the pulp during the cook. (2) One fourth of the hemicelluloses removed during the cook can be recovered from the spent liquor in a relatively undegraded form with respect to molecular size. (3) The hemicelluloses remaining in the pulp are not degraded but are apparently made more accessible to caustic extraction. (4) The hemicelluloses from the pulp or pulp holocelluloses have greater intrinsic viscosities than the corresponding ones from aspenwood or aspenwood holocelluloses but the chemical analyses are quite similar. (5) There were no free simple sugars, di-, or trisaccharides in the NSSC spent liquors. (6) Degradation products of the pentosans are probably responsible for much of the ultraviolet absorption at 280 mmu of the filtrates from the lignin determination of high-pentosan, low-lignin containing materials such as hemicelluloses.

An investigation of the effect of the neutral sulphite semichemical cook on the hemicelluloses of aspenwood was undertaken because of the increasing importance of semichemical pulping and the increasing interest in the role of the hemicelluloses in the papermaking properties of pulps.

David C. Lea, graduate student, The Institute of Paper Chemistry, Appleton, Wis.; present address, Potlatch Forests, Inc., Lewiston, Idaho.

NSSC pulping consists of cooking chips under pressure at about 170°C. in a solution of neutral sodium sulphite buffered with sodium carbonate. Under controlled conditions this results in the solution of only 15 to 30% of the weight of the wood. Perhaps 30 to 45% of the hemicelluloses and 50 to 75% of the lignin are removed from hardwoods during the NSSC cook (*1–4*). Aries (*5*) suggested that the spent liquor should contain sodium lignosulphonate, sodium salts or organic acids, sodium sulphate, sodium sulphite, and residual sodium bicarbonate. Hitherto the fate of the carbohydrate material emanating from the original hemicelluloses of the wood and removed during the cook has remained unknown.

There is no generally accepted definition of the term *hemicelluloses.* Inasmuch as the present work involves a study of the fate of hemicellulosic material in the course of a pulping process, it is well to state what the term "hemicellulose" actually signifies. As used in this article hemicelluloses refer to polysaccharides extracted by means of aqueous alkali from wood, holocellulose, or pulp followed by acidification of such an extract and by its precipitation with alcohol. It also refers to carbohydrate material, precipitable with alcohol from suitably treated spent liquors of the cook.

It has been shown that more hemicellulosic material can be extracted from a partially delignified intermediate, such as a holocellulose, than can be extracted directly from the wood. Among the methods of preparing holocellulose are the chlorine dioxide–pyridine method of Schmidt, Tang, and Jandebeur (*6*), the chlorite procedure of Jayme (*7*), and its modification by Wise, Murphy, and D'Addieco (*8*), the chlorine ethanolamine method of Van Beckum and Ritter (*9*), and the modifications of the latter by Thomas (*10*) and Timell and Jahn (*11*). Wethern (*12*) has shown that hemicelluloses extracted from a holocellulose prepared by the Thomas method have slightly higher molecular weights than those of hemicelluloses extracted from chlorine dioxide–pyridine or chlorite holocellulose prepared from the same material.

The sugar units occurring in hemicellulosic materials may be identified by a complete hydrolysis followed by suitable chromatographic absorption and subsequent identification. The presence of such units helps in the characterization of the original hemicellulose.

Paper partition chromatography consists in general of the partition of a solute between a mobile solvent phase and a stationary phase consisting of a cellulose-water complex. The solvent system is a mixture of water and some organic liquid along with acidic materials, basic materials, or buffers to give the desired solubilities and partition between phases. These materials also affect the speed of travel of the solvent. The procedure has been adapted to both qualitative and quantitative analysis of the sugars, and was used in the present study.

In the course of these studies lignin determinations were frequently made by the Klason procedure. This involves the separation of an acid-insoluble lignin, but is reputed to be far from quantitative (*13, 14*), with the assumption that a portion of the lignin remains dissolved in the filtrates. This soluble lignin is determined by an ultraviolet method described later in this article. However, in the course of this study, it was shown that at least a portion of such a soluble lignin may be due to the action of acids on the sugars themselves and this possible error is discussed.

EXPERIMENTAL

Glossary

A glossary of the symbols used to indicate the various materials used and preparations made in this study is listed below.

Symbol	Material
W	Aspenwood shavings.
W-D5	Hemicellulose extracted with 5% potassium hydroxide from aspenwood shavings.
W-D16	Hemicellulose extracted with 16% potassium hydroxide from the aspenwood shavings previously extracted with 5% potassium hydroxide.
W-DR	Residue from the aspenwood shavings after extraction with 5 and 16% potassium hydroxide.
W-H	Holocellulose prepared from aspenwood shavings by the Thomas procedure.
W-H5	Hemicellulose extracted from W-H with 5% potassium hydroxide.
W-H16	Hemicellulose extracted with 16% potassium hydroxide from W-H previously extracted with 5% potassium hydroxide.
W-HR	Residue from W-H after extraction with 5 and 16% potassium hydroxide.
P2	Pulp from NSSC cook 2.
P3	Pulp from NSSC cook 3.
P4	Pulp from NSSC cook 4.
P2-D5	Hemicellulose extracted from pulp 2 with 5% potassium hydroxide.
P2-D16	Hemicellulose extracted with 16% potassium hydroxide from pulp 2 which had been previously extracted with 5% potassium hydroxide.
P2-H	Holocellulose prepared from pulp 2 by the Thomas procedure.
P2-H5	Hemicellulose extracted from P2-H with 5% potassium hydroxide.
P2-H16	Hemicellulose extracted with 16% potassium hydroxide from P2-H which had been previously extracted with 5% potassium hydroxide.
P2-HR	Residue from P2-H after extraction with 5 and 16% potassium hydroxide.
2-SL	Spent liquor from NSSC cook 2.
3-SL	Spent liquor from NSSC cook 3.
4-SL	Spent liquor from NSSC cook 4.
2-SL-B	Hemicellulose recovered from 2-SL.
3-SL-B	Hemicellulose recovered from 3-SL.
4-SL-B1	Hemicellulose recovered from 4-SL (first sample).
4-SL-B2	Hemicellulose recovered from 4-SL (second sample).

Table I. Pulping Conditions, Pulp, and Spent Liquor Data

	Cook no. 2	Cook no. 3	Cook no. 4
Chemical			
Sodium sulphite as Na_2SO_3, %	12	12	12
Sodium carbonate as Na_2CO_3, %	5	7	5.25
Water ratio, ml./g.[a]	4	4	4
Maximum temperature, °C.	170	170	170
Time to max. temp., min.	120	120	120
Time at max. temp., min.	90	90	90
Maximum pressure, p.s.i.	129	121	128
Relief time, min.	15	15	15
Chip charge, moisture-free, g.	3314	3314	3314
Pulp yield, moisture-free, g.	2470	2453	2482
Pulp yield, %[b]	74.5	74.0	74.9
Spent liquor,[c] pH	6.5	9.1	7.4

[a] Distilled water was used to make up the cooking liquors.
[b] Moisture-free wood basis.
[c] There were no sugar units, disaccharides, or trisaccharides in any of these spent liquors (chromatographic analysis).

Preparation of Materials

Aspenwood Chips and Shavings. Chips (3/4 in.) and thin shavings made with a power planer were prepared from four aspenwood logs selected at random from the woodyard of a local mill.

Pulps. The chips were cooked in a 10-lb., stainless steel laboratory digester equipped with positive liquor circulation and heated with an external heat exchanger. The chips, after the removal of residual cooking liquor, were defibered in a Bauer refiner and washed thoroughly with warm water. The washed pulps were air dried and stored in a cold room (6°) in pliofilm bags.

The experimental conditions and pulping data are shown in Table I.

Holocelluloses. The holocelluloses were prepared from aspen shavings and from pulp 2 by the Thomas procedure as described by Wethern (*12*). Yields on the moisture-free, extractive-free, ash-free basis were 79.4% from the aspenwood shavings and 85.7% from pulp 2. Analytical data for the holocelluloses are shown in Table IV.

Hemicelluloses. Hemicelluloses were extracted from the aspenwood shavings and from pulp 2 with 5% followed by 16% potassium hydroxide. The procedure of Wethern (*12*) was used and the extractions were carried out under nitrogen. The hemicelluloses were precipitated by pouring the alkaline, filtered extract into 4 volumes of 95% ethanol which contained enough concentrated acetic acid to more than neutralize the potassium hydroxide. After standing for 48 hr., the supernatant liquor was siphoned off and the hemicelluloses were separated by centrifugation. They were washed four times with 95% ethanol and three times with C.P. ethyl ether. After drying for 48 hr. under vacuum at room temperature, the hemicelluloses were broken up into fine powders. The yields of the various extracts are shown in Table II.

Table II. Hemicellulose Yields

	Wood, %[a]		Wood, %[a]
W-D5	10.5	W-D5 plus W-D16	15.3
W-D16	4.8	W-H5 plus W-H16	22.5
W-H5	17.7	P2-D5 plus P2-D16	14.2
W-H16	4.8	P2-H5 plus P2-H16	14.8
P2-D5	9.8	2-SL-B	1.4
P2-D16	4.4	3-SL-B	1.0
P2-H5	11.0	4-SL-B1	2.0
P2-H16	3.8	4-SL-B2	1.6

[a] Moisture-free, extractive-free, ash-free basis.

Table III. Hemicellulose Analyses

	Ash, R[a]	*Lignin*, %[b]	*"Apparent" lignin in the filtrate*[b]	*Pentosans*, %[b, c]	*Uronic anhydride*, %[b]	*Color*
W-D5	7.8	2.0	7.3	77.5	15.7	Cream
W-D16	6.8	4.5	7.4	74.6	12.6	Light tan
W-H5	9.0	0.9	7.6	71.7	20.1	Gray white
W-H16	7.4	0.4	5.5	72.6	17.7	White
P2-D5	7.6	2.0	7.3	81.2	11.1	Gray white
P2-D16	4.9	1.6	7.6	79.3	10.5	Gray white
P2-H5	7.0	0.4	8.3	77.2	12.5	White
P2-H16	6.2	0.4	6.5	81.7	11.2	White
4-SL-B1[d]	8.8	...	...	64.7	13.2	Gray
4-SL-B2[d]	9.3	...	...	69.6	14.2	White

[a] Moisture-free basis.
[b] Moisture-free, ash-free basis.
[c] Corrected for uronic anhydride.
[d] Analyses were single determinations by micromethods.

"Hemicelluloses" from the Spent Liquors. A "hemicellulosic" material was recovered from the NSSC spent liquors by a procedure developed in the present study, which consisted of the following steps: (1) acidification with sulphuric acid to the methyl red end point, (2) precipitation of the larger lignosulphonic acid molecules with "bis"* (*15*, *16*), (3) neutralization of the sulphuric acid with barium carbonate or barium hydroxide, (4) deionization after filtration and centrifugation, with cation and anion ion exchange columns, (5) concentration under reduced pressure, and (6) precipitation in absolute alcohol. It was possible to exclude step (2) and still obtain a precipitate. However, the precipitate was dark gray in color and contained considerable lignin.

The yield data for the "hemicelluloses" from the spent liquors are listed in Table II.

Methods of Analysis

Ash. Aspenwood shavings—Institute Method 4 (1952); Other materials—Institute Method 422 (1952).

Lignin. Aspenwood shavings—Institute Method 13 (1952); other materials—Institute Method 428 (1952).

The presence of acid-soluble lignin in pulps and the estimation of lignin by the ultraviolet absorption at 280 mmu was studied by Trucano (*17*). Campbell and McDonald (*14*) recently reported the presence of 7.4% acid-soluble lignin in beech and 5.8% in sprucewood. Browning and Bublitz (*13*) have studied the acid-soluble lignin in sprucewood and the effect of the degradation products from the carbohydrate fraction upon the ultraviolet absorption of the filtrates from lignin determinations.

In the present investigation the ultraviolet absorption at 280 mmu was determined on samples of the filtrates from lignin analyses. The acid-soluble or "apparent lignin" values for each analysis were calculated from the following relationship:

$$a = A/bc$$

where

a = specific extinction coefficient at 280 mmu for aspen native lignin; a value of 15 was used (*18*)
b = internal cell length in centimeters
c = concentration in grams per liter
A = optical density

The Klason lignin values and the calculated apparent lignin values are shown in Tables III and IV. In addition the ultraviolet absorption curves for several of the filtrates and the curves for several related substances—aspen native lignin, spruce native lignin, and furfural—are shown in Figs. 1 and 2.

Pentosans. Institute Method 424 (1952).

Uronic Anhydride. Institute Method 25 (1952).

The data for the ash, pentosan, and uronic anhydride analyses are given in Tables III and IV.

Qualitative Sugar Analysis. Qualitative sugar analyses were made on the wood, pulp, holocelluloses, hemicelluloses, and residues after appropriate extractions and hydrolyses. Either a portion of the filtrate from the Klason lignin determination or a portion of a 3% sulphuric acid hydrolyzate was used. The hydrolysis consisted of boiling for 4 hr. at constant volume. A portion of the filtrate or hydrolyzate was heated on a steam bath, quickly neutralized with barium carbonate, and immediately filtered in a Buchner funnel through two filter papers. The filtrate was refiltered through a 0.5-cm. pad of purified, medium, acid-washed asbestos which had been formed in a 30-mm., coarse-fritted glass filtering funnel. The resulting clear solution was passed through a cation ion exchange column (Ionac C-200 or Amberlite IR-120). The column was washed with 2 or 3 volumes of distilled water and the combined

* 4,4-bis-(dimethylaminophenyl) methane.

Table IV. Analyses of Aspenwood, Pulp 2, Holocelluloses, and Residues

	Ash, %	*Lignin*, %	*"Apparent" lignin in the filtrate*[c]	*Pentosans*, %	*Uronic anhydride*, %
W	0.5[a]	18.0[d]	5.6[d]	17.3[d]	6.1[d]
W-DR	1.5[b]	21.8[c]	6.0[c]	7.3[c]	4.3[c]
W-H	0.5[b]	0.6[c]	7.0[c]	20.3[c]	7.9[c]
W-HR	0.4[b]	0.5[c]	3.9[c]	1.3[c]	1.8[c]
P2	1.4[a]	12.3[e]	7.1[e]	17.7[e]	4.1[e]
P2-DR	0.9[b]	13.7[c]	5.1[c]	1.5[c]	3.6[c]
P2-H	0.1[b]	0.4[c]	4.4[c]	19.3[c]	3.9[c]
P2-HR	0.2[b]	0.4[c]	3.1[c]	1.2[c]	1.3[c]
Aspen native lignin[b]	...	91.7	4.4	...	...
Xylose[f]	...	...	6.9	...	...
Yundt's xylan[f]	...	...	4.2	...	...

[a] Moisture-free, extractive-free basis.
[b] Moisture-free basis.
[c] Moisture-free, ash-free basis.
[d] Moisture-free, ash-free, extractive-free wood basis.
[e] Moisture-free, ash-free, extractive-free pulp basis.
[f] Boiled with 3% sulphuric acid for 4 hr.

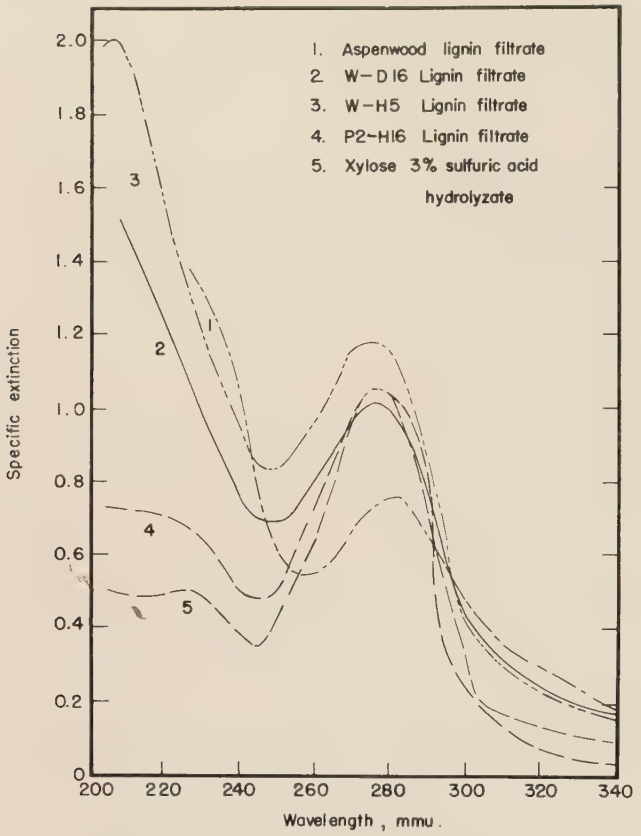

Fig. 1. Ultraviolet absorption curves (1–5)

solution and washings were concentrated to a thin sirup at 50°C. under reduced pressure.

Chromatograms on Whatman no. 1 filter paper strips were developed for 16 to 20 hr. in a developing tank containing an acid solvent system [ethyl acetate-acetic acid-water (9:2:2)]. Subsequently they were removed and dried and then developed for 48 hr. in a developing tank containing a pyridine solvent system [butanol-pyridine-water (10:3:3)]. The pyridine system separated the common sugars found to be present in the hydrolyzates, excepting mannose and arabinose. The acid system separated all the sugars except glucose and galactose. By combining the two solvent systems a separation of all the sugars, if present, was effected on a single chromatogram. The results of the qualitative analysis are shown in Tables V and VI.

Quantitative Analysis. In estimating quantitatively the amounts of the sugars in the various materials studied, a modification of the paper chromatographic techniques of Hirst and Jones (*19*) and of Leech (*20*) was employed. Essentially the procedure was as follows:

A known amount of the material was hydrolyzed with sulphuric acid, or a known volume of the filtrate from the Klason lignin determination was used. To the hydrolyzate or filtrate a weighed amount of a reference sugar—rhamnose or ribose—roughly equal to one half the major sugar constituent was added. The mixture was neutralized, filtered, passed through a cation ion exchange column, and concentrated to a thin sirup as described in the qualitative analysis procedure.

Paper strip chromatograms, 14 to 16 cm. in width, were prepared. A fine line of the sirup was laid across the paper 8 cm. from the top. The chromatograms were developed for 24 hr. in the pyridine system and were removed and dried. The dried strips were then returned to the pyridine tank and developed for a second period of 24 hr. after which they were again removed and dried. After a third developing period of 24 hr. the chromatograms were again removed and dried. This intermittent drying procedure tended to compress the various sugar bands and to sharpen the separation, although the distances between individual bands were lessened. When it became necessary to separate mannose and arabinose, separate chromatograms were developed in the acid system.

After the final drying, guide strips 2.5 cm. wide were cut from each side of the chromatograms. These were sprayed with either aniline hydrogen phthalate (*21*) or *p*-anisidine hydrochloride (*22*) spray reagent.

The sprayed strips were heated in an oven at 110° for 5 min. to develop the colors and were then reattached in appropriate positions to the chromatograms with cellophane tape. The bands for the various sugars were marked on the unsprayed portions, and were cut out after suitable identification. Blanks were also cut from portions of the chromatograms which contained no sugar.

The sugars and the blank were eluted from the strips and transferred to reaction flasks which were glass tubes, with slightly enlarged bulbs at the bottom and equipped with ground glass stoppers. They were approximately 2.5 cm. in diameter and 22 cm. long. The bulb had a diameter of 4 cm. A photograph of a reaction flask and the eluting apparatus is shown in Fig. 3.

One milliliter of a 0.25 molar solution of sodium periodate was added to each flask containing the eluate and rinsings, and the flasks were heated by direct steam in the steam bath for 12 min. After heating, they were

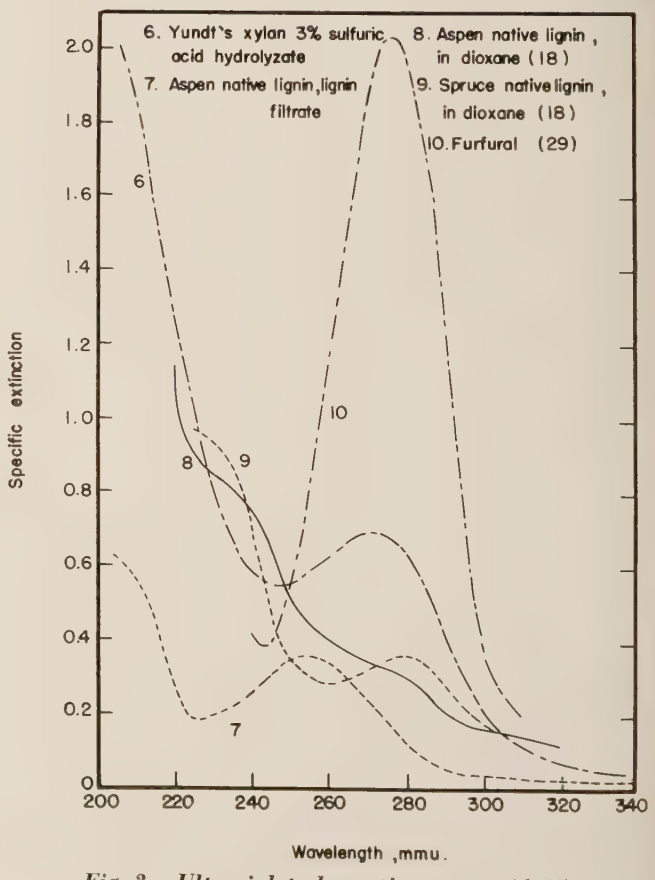
6. Yundt's xylan 3% sulfuric acid hydrolyzate
7. Aspen native lignin, lignin filtrate
8. Aspen native lignin, in dioxane (18)
9. Spruce native lignin, in dioxane (18)
10. Furfural (29)
Specific extinction
Wavelength, mmu.

Fig. 2. Ultraviolet absorption curves (6–10)

Table V. Sugars Found by Chromatography in Hydrolyzates of the Hemicelluloses[a]

	Glucose, %[b]	Galactose, %[b]	Mannose, %[b]	Xylose, %[b]	Arabinose, %[b]	Rhamnose, %[b]
W-D5	...	...	...	100—	...	Slight trace
W-D16	7.6	3.0	1.0[c]	87.4	1.0[c]	Slight trace
W-H5	Trace	Trace	...	100—	Trace	Slight trace
W-H16	Trace	Trace	Slight trace	100—	Slight trace	Slight trace
P2-D5	...	...	...	100—	...	Slight trace
P2-D16	4.2	Slight trace	Slight trace	95.8	Slight trace	Slight trace
P2-H5	Trace	Trace	...	100—	Slight trace	Slight trace
P2-H16	Trace	Trace	Slight trace	100—	Slight trace	Slight trace
2-SL-B	Trace	Trace	...	91.4	8.6	...
4-SL-B1	4.6	5.7	...	81.7	8.0	...
4-SL-B2	4.6	6.7	...	80.5	8.2	Trace

[a] Does not include those sugar units, such as xylose, which may be firmly linked to the uronic acid units.
[b] Percentage as a pentosan or hexosan of the total pentosans and hexosans present. Percentages were calculated from the quantitative analysis data.
[c] Mannans and arabans were determined together and each was arbitrarily assumed to constitute half of the total.

immediately cooled under a cold water tap and placed in a container of cold water. To the cooled reaction solution 0.5 ml. of ethylene glycol was added to consume any unused periodate. The flasks were shaken vigorously and allowed to stand 10 min. for the reaction between the periodate and the glycol to be completed. The formic acid formed in the reaction was titrated with standard sodium hydroxide (approximately 0.004 *N*)

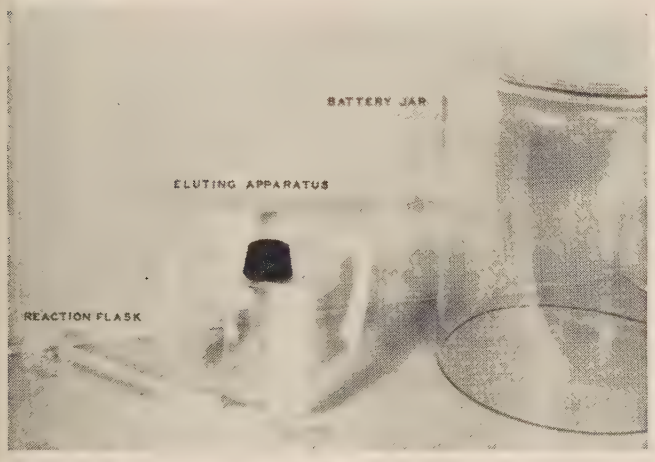

Fig. 3

to a greenish-yellow color, using methyl red as an indicator (0.02 gram methyl red in 60 ml. of 95% alcohol and 40 ml. distilled water).

The data from the quantitative analyses were shown in Tables V, VI, and VII. The "percentage of the adjusted sample" in Table VII was calculated by dividing the sum of the weights of sugar anhydride units (obtained by chromatographic analysis) by an adjusted sample weight. The adjusted sample weight was determined by subtracting the weight of the lignin and uronic anhydride from the oven-dry, ash-free sample weight. *The adjusted sample weight was not corrected for the pentose or hexose sugar units combined with the uronic acids to form difficultly hydrolyzable compound uronic acids.*

The sum of the weights of xylan and araban as determined by chromatographic analysis was multiplied by factors calculated from Kröbers (*23*) tables in order that they would be on the same basis as the pentosans determined by furfural evolution. This sum was then multiplied by 100 and divided by the moisture-free, ash-free sample weight to give a chromatographically determined pentosan value for comparison with the pentosan value obtained by furfural evolution.

Viscosities of the Hemicelluloses. The intrinsic viscosities of the hemicelluloses were determined in 10% potassium hydroxide according to the method described by Thompson and Wise (*24*) and Wethern (*12*). The degrees of polymerization (D.P.) and molecular weights (M.W.) were calculated from the formulas $[\eta] = K'(\text{M.W.})$ and $[\eta] = K''(\text{D.P.})$, where $[\eta]$ is the intrinsic viscosity and K' and K'' are experimentally determined constants (*24*). The data from the viscosity determinations are listed in Table VIII.

DISCUSSION AND CONCLUSIONS

The yields of the hemicelluloses show that 7.7% of the weight of the wood or 34.2% of the hemicelluloses originally present were removed from the wood by NSSC cook 2. The loss of pentosans (4.3% of the weight of the wood) plus the uronic anhydride (3.04% of the weight of the wood) was almost equal to the hemicelluloses removed—7.3 as compared to 7.7%. It was possible by chromatographic analysis of the spent liquor

Table VI. Sugars Found by Chromatography in Hydrolyzates of Aspenwood Shavings, Pulp 2, Holocelluloses, Residues, and Spent Liquors[a]

	Glucose, %[b]	Galactose, %[b]	Mannose, %[b]	Xylose, %[b]	Arabinose, %[b]	Rhamnose, %[b]
W	68.5	Trace	1.3[c]	29.0	1.3[c]	Trace
W-DR	88.3	Slight trace	1.1[c]	9.5	1.1[c]	Slight trace
W-H	70.0	1.2	1.4[c]	25.9	1.4[c]	Slight trace
W-HR	100—	...	Trace	Trace	Slight trace	...
P2	76.0	Slight trace	Trace	24.0	Slight trace	Slight trace
P2-DR	97.7	...	Slight trace	2.3	...	...
P2-H	74.2	Slight trace	0.9	24.9	Slight trace	Slight trace
P2-HR	96.4	...	1.6	2.0	...	...
2-SL	4.1	8.9	2.9	75.3	6.2	2.6
3-SL	8.1	9.5	2.3	66.6	7.6	5.8
4-SL	6.4	9.8	3.5	69.9	6.1	4.3

[a] Does not include those sugar units, such as xylose, which may be firmly linked to the uronic acid units.
[b] Percentage as a pentosan or hexosan of the total pentosans and hexosans present. Percentages were calculated from the quantitative analysis data.
[c] Mannans and arabans were determined together and each was arbitrarily assumed to constitute half of the total.

Table VII. Quantitative Sugar Determinations

Material hydrolyzed	*Type of hydrolysis*	*Reference sugar*	*Adjusted sample, %*	*Pentosans (calculated), %*[a]	*Pentosans by furfural detn., %*[b]
W-D5	Lignin filtrate	Rhamnose	76.2	69.5	77.5
W-D16	Lignin filtrate	Rhamnose	87.2	69.8	74.6
W-H5	3% sulphuric acid	Rhamnose	65.8	57.5	71.7
		Ribose	80.0	69.8	71.7
W-H16	Lignin filtrate	Rhamnose	77.6	70.2	72.6
		Ribose	98.2	88.9	72.6
P2-D5	Lignin filtrate	Rhamnose	74.5	71.5	81.2
		Ribose	80.0	76.6	81.2
P2-D16	3% sulphuric acid	Rhamnose	76.4	74.3	79.3
		Ribose	86.3	83.0	79.3
P2-H5	3% sulphuric acid	Rhamnose	72.0	69.0	77.2
		Ribose	102.2	98.0	77.2
P2-H16	Lignin filtrate	Rhamnose	77.6	74.5	81.7
		Ribose	87.7	85.6	81.7
W	Lignin filtrate	Rhamnose	67.0	16.2	17.3
W-DR	Lignin filtrate	Rhamnose	93.0	7.5	7.3
W-H	Lignin filtrate	Rhamnose	86.0	22.4	20.3
W-HR	Lignin filtrate	Rhamnose	94.5	...	1.3
P-2	Lignin filtrate	Rhamnose	82.7	17.0	17.7
		Ribose	96.0	19.8	17.7
P2-DR	Lignin filtrate	Ribose	81.4	1.7	1.5
P2-H	Lignin filtrate	Rhamnose	81.8	21.6	19.3
P2-HR	Lignin filtrate	Rhamnose	76.9	1.4	1.2
4-SL-B1	3% sulphuric acid	Ribose	74.5	57.8	64.7
4-SL-B2	3% sulphuric acid	Ribose	75.7	62.7	69.6

[a] From chromatographic data.
[b] Corrected for uronic anhydride.

to account for over half of the hemicelluloses lost. (The yield of sugar anhydride in the spent liquor was 4.1% of the weight of the wood.) The hemicelluloses actually recovered by precipitation from the spent liquor were equal to approximately one-fourth of the hemicelluloses lost during the cook. The difference between the amounts of carbohydrate material obtained by sugar analysis of the spent liquor and by recovery of hemicelluloses from the spent liquor may be due to a lignin-carbohydrate bond which would cause carbohydrate material to be retained with the lignosulphonates on the anion ion exchange column. This hypothesis requires experimental verification.

The NSSC cook appears to render the hemicelluloses in the pulp more accessible to caustic extraction than those in the original aspenwood. The hemicelluloses removed directly by alkaline extraction from pulp 2 were equal to about 95% of the total hemicelluloses in the pulp. The hemicelluloses extracted directly from the aspenwood shavings were equal to about 68% of the total hemicelluloses from the aspenwood. (Total hemicelluloses are defined in this study as the sum of the hemicelluloses extracted by 5 and 16% potassium hydroxide from the "holocelluloses" prepared from pulp 2 or aspenwood shavings.)

The analytical data for the hemicelluloses (Table III) show that the hemicelluloses extracted from pulp 2 or from the holocellulose prepared from this pulp have in general a higher pentosan content and a lower uronic acid content than the corresponding ones extracted from aspenwood shavings or aspenwood holocellulose. The uronic acid fractions of the hemicelluloses are apparently more easily removed in the NSSC cook or by 5% potassium hydroxide than are the pentosan fractions. The pentosan content of the pulp was 17.7 as compared to 17.3% for the aspenwood shavings; on the other hand, the percentage of uronic anhydride in the pulp was 4.1 as compared to 6.1 in the aspenwood shavings. Likewise all the hemicelluloses extracted with 5% potassium hydroxide have higher percentages of uronic acids than do the 16% extracts from the same materials. Similar results were noted by Wise and Ratliff (*26*). This relationship does not hold for the pentosan contents of the hemicelluloses.

The analytical data for the hemicelluloses recovered from the spent liquors were similar to those of the extracted hemicelluloses except that the percentages of pentosans were lower in the spent liquor hemicelluloses.

The extracted hemicelluloses contain predominantly xylose sugar units. W-D16 and P2-D16 contained appreciable amounts of glucose units (7.6 and 4.2%, respectively); W-D16 also contained measurable amounts of galactose, mannose, and arabinose units. The other extracted hemicelluloses contained only traces of sugar units other than xylose.

In general, the hydrolyzates of the hemicelluloses from pulp 2 contained the same sugars in approximately the same proportions as did the hydrolyzates of the corresponding hemicelluloses from aspenwood.

Galactose, mannose, arabinose, and rhamnose sugar units were concentrated in the spent liquors. The

Table VIII. Intrinsic Viscosities, Degrees of Polymerization and Molecular Weights of the Hemicelluloses

Hemicellulose	*Intrinsic viscosity*	*Degree of polymerization*[a,b]	*Molecular weight*[a]
W-D5	0.54	123	16,200
W-D16	0.67	152	20,100
W-H5	0.59	134	17,700
W-H16	0.76	173	22,800
P2-D5	0.63	143	18,900
P2-D16	0.68	155	20,400
P2-H5	0.68	155	20,400
P2-H16	0.71	161	21,300
2-SL-B	0.48	109	14,400
3-SL-B	0.54	123	16,200
4-SL-B1	0.44	100	13,200
4-SL-B2	0.48	109	14,400
W-D5 plus W-D16[c]	0.58	132	17,400
W-H5 plus W-H16[c]	0.63	143	18,900
P2-D5 plus P2-D16[c]	0.64	146	19,200
P2-H5 plus P2-H16[c]	0.69	157	20,700

[a] Number average.
[b] As a pentosan.
[c] Calculated according to a procedure suggested by Wales, Williams, Thompson, and Ewart (*25*).

NSSC cook appears to remove them proportionately more fully from the wood than it does the xylose.

Both rhamnose and ribose were investigated as reference sugars and the latter proved to be a much better reference sugar for analysis of the type of materials studied. Although not shown by the data in Table VII, ribose gave more precise results in duplicate determinations.

The quantitative sugar analysis did not give completely satisfactory results. This is shown by the "percentage of the adjusted sample" data in Table VII where, with rhamnose as a reference sugar, the percentage of the adjusted sample varied from 66 to 95%. With ribose as a reference sugar 75 to 102% of the adjusted sample was accounted for.

The 3% sulphuric acid hydrolysis appeared to be most effective for the hemicelluloses. For those materials containing cellulose, treatment with 72% sulphuric acid was essential and even under these more drastic conditions some cellobiose and cellotriose appeared to be present in the hydrolyzates.

Among the drawbacks of the present method of quantitative chromatographic analysis as applied to the materials analyzed in this study are: (1) degradative effects of the hydrolysis step on certain of the sugar groups—xylan in particular, (2) incomplete hydrolysis of cellulose to glucose, (3) heterogeneity of the materials analyzed.

The quantitative method provides a rapid, fairly accurate means of estimating the amounts of the various sugars in the hydrolyzates of carbohydrate containing materials such as wood, holocelluloses, and hemicelluloses.

The NSSC cook preferentially removes the hemicelluloses of somewhat smaller molecular magnitude and leaves a considerable portion (25%) of these hemicelluloses, which are removed, in the spent liquor in an essentially undegraded condition. The viscosities of the hemicelluloses extracted from the pulp were higher than the viscosities of the corresponding hemicelluloses from the original aspenwood. The viscosities of the hemicelluloses extracted from the holocelluloses were higher than the viscosities of the hemicelluloses extracted directly from the corresponding wood or pulp even though the yield of hemicelluloses was greater from the holocelluloses. The viscosities of the hemicelluloses recovered from the spent liquor were somewhat lower than those of the various extracted hemicelluloses. These data indicate that the NSSC cook does not materially decrease the molecular magnitude of the hemicelluloses.

The ultraviolet absorption curves in Figs. 1 and 2 show that neither aspen native lignin nor the filtrate from a Klason lignin determination on aspen native lignin have the characteristic maximum at 280 mmu or the characteristic minimum at 260 mmu that spruce native lignin exhibits. The curves for the hemicelluloses resemble the curves for furfural (no. 10). Furfural is a degradation product when pentosans are subjected to treatment with hot sulphuric acid (*27*).

The ultraviolet absorption curve for a xylose solution treated with hot 3% sulphuric acid for 4 hr. (no. 5) resembles those of the hemicelluloses and has an "apparent" lignin value of 6.9%. Similar results were found by Rollinson and Wise (*28*). Sohn (*29*) refluxed a 0.0033 molar solution of xylose (initial pH 6.5) for 19 hr. and found that the optical density at 280 mmu increased steadily with time of refluxing. He obtained curves similar to curve no. 5.

The large specific extinction coefficient at 280 mmu for furfural (100) should be noted. When this is compared to the specific extinction coefficient at 280 mmu for aspen native lignin (*15*) it can be seen that a small amount of furfural in a lignin filtrate would have a large effect on its optical density and hence upon the "apparent" lignin content.

LITERATURE CITED

1. McGovern, J. N., *Tappi* 33, No. 10: 486–489 (Oct., 1950).
2. Herbst, J. H. E., and Marshall, H. B., *Pulp Paper Mag. Can.* 52, No. 13: 106–109(Dec., 1951).
3. McGovern, J. N., *Pulp Paper Mag. Can.* 49, No. 9: 93–100 (Aug., 1948).
4. Keller, E. L., and McGovern, J. N., *Tappi* 32, No. 9: 400–405(Sept., 1949).
5. Aries, Robert S., *Paper Trade J.* 128, No. 2: 21–26 (Jan. 13, 1949).
6. Schmidt, Erich, Tang, Yüan-Chi, and Jandebeur, Wilhelm, *Cellulosechemie* 12, No. 7: 201–212(July 5, 1931).
7. Jayme, G., *Cellulosechemie* 20, No. 2: 43–49(March, April, 1942).
8. Wise, Louis E., Murphy, Maxine, and D'Addieco, Alfred A., *Paper Trade J.* 122, No. 2: 35–43(Jan. 10, 1946); *Tech. Assoc. Papers* 29: 210–218(1946).
9. Van Beckum, William G., and Ritter, George J., *Paper Trade J.* 104, No. 19: 49–50(May 13, 1937); 105, No. 18: 127–130 (Oct. 28, 1937), 108, No. 7: 27–29 (Feb. 16, 1939); 109, No. 22: 107–109(Nov. 30, 1939).
10. Thomas, Berwyn B., *Paper Ind.* 26, No. 10: 1281–1284 (Jan., 1945).
11. Timell, T. E., and Jahn, E. C., *Svensk Papperstidn.* 54: 831–846(1951).
12. Wethern, J. D., *Tappi* 35, No. 6: 267–271(June, 1952).
13. Browning, Bertie L., and Bublitz, L. O., *Tappi* 36, No. 10: 452–458(Oct., 1953).
14. Campbell, W. G., and McDonald, I. R. C., *J. Chem. Soc.* 3180–3183(Aug., 1952).
15. Erdtman, Holger, *Svensk Papperstidn.* 45, No. 16: 315–323(1942); No. 18: 374–380(1942).
16. Larsson, Alver, *Svensk Papperstidn.* 46, No. 5: 93–100 (1943).
17. Trucano, Peter J., The action of sodium sulphite on sprucewood. Doctor's Dissertation. Appleton, Wis. See *Tappi* 37, No. 7: 294, Reference No. 15, The Institute of Paper Chemistry, 1947. 100 pages.
18. Buchanan, M. A., Brauns, F. E., and Leaf, R. L., Jr., *J. Am. Chem. Soc.* 71: 1297–1299(1949).
19. Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.* 1949: 1659–1662.
20. Leech, Howard J., An investigation of the reasons for increase in paper strength when beater adhesives are used. Doctor's Dissertation. Appleton, Wis. See *Tappi* 37, No. 7: Reference No. 15, The Institute of Paper Chemistry, 1953. 118 pages.
21. Partridge, S. M., *Nature* 164, No. 4167: 443(Sept. 10, 1949).
22. Hough, L., Jones, J. K. N., and Wadman, W. H., *J. Chem. Soc.* 1950: 1702–1706.
23. Bates, F. J., and associates, "Polarimetry, saccharimetry and the sugars," pages 610–611, Washington, U. S. Govt. Printing Office, 1942, 810 pages.
24. Thompson, James O., and Wise, Louis E., *Tappi* 35, No. 7: 331–336(July, 1952).
25. Wales, Michael, Williams, J. W., Thompson, J. O., and Ewart, R. H., *J. Phys. Colloid Chem.* 52, No. 6: 983–988 (June, 1948).
26. Wise, Louis E., and Ratliff, Evelyn K., *Ind. Eng. Chem., Anal. Ed.* 19: 459–462(July, 1947).
27. Browning, Bertie L., "The polysaccharide fraction of wood," *in* Wise and Jahn, "Wood Chemistry," 2nd ed., vol. 2, New York, Reinhold, 1952.
28. Rollinson, Ruth R., and Wise, Louis E., Unpublished work, 1953.
29. Sohn, A. W., *Das Papier* 4, No. 19/20: 379–384(Oct., 1950).

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The Measurement of Gloss of Waxed Paper

P. J. GIANACAKES

A study was made to determine whether the visual gloss of waxed paper could be reliably measured with an instrument. Light-distribution studies made with a goniophotometer resulted in the development of a new method for measuring gloss. The method measures the amount of light specularly reflected at 45° and correlates better with visual gloss than the 20° ASTM, 60° ASTM, or 75° TAPPI methods, which were developed for other surfaces. Increased accuracy at the extremes of the gloss range can be obtained by using modifications of the method. For low gloss, the 45° gloss test with a circular receptor aperture is used. For high gloss, the Gonio Gloss Index—a number describing the gloss represented by a complex goniophotometric curve—is used.

PAPER products coated with petroleum wax are used extensively today in the packaging of foods. Between 1940 and 1952, wax consumption by the paper industry increased from 370 to 1200 million lb. annually, or about 225%. Initially used only to preserve food quality, waxed papers now must also add to sales appeal. For this reason, a glossy waxed paper is preferred to one that is dull or lusterless. An idea of the glossiness of waxed paper may be obtained by visual observation. At best, however, this method is poor for (1) comparing gloss observations made at different times, (2) controlling the quality of waxed paper, or (3) studying the factors that contribute to gloss. A more accurate instrumental method of gloss measurement is, therefore, needed.

Investigators have applied instruments to the measurement of gloss of various surfaces. These instruments, in general, are of two types: (1) fixed-angle glossmeters, which measure the light reflected in the mirror direction, and (2) goniophotometers, which measure both scattered and reflected light. A measure of the light reflected in the mirror direction is termed specular reflectance, and a measure of the scattered and reflected light is termed directional reflectance. Gloss measurements have been made on photographic paper (*9*), printing paper (*2*), and painted surfaces (*5, 6, 11*), but not on waxed paper.

A study of the measure of gloss of waxed paper was undertaken. Included were commercial food wrappers, that varied widely in gloss. These papers were first visually rated by a panel as poor, fair, good, excellent, or superior. Ratings were made under identical lighting conditions, and the average rating was used as the visual gloss of the sample. Optical studies of the light reflectance were then made with a goniophotometer. These studies led to the development of a gloss test that correlated well with visual gloss.

METHOD

The glossiness of a waxed paper was determined by measuring the amount of light specularly reflected at 45° with a modified Hunter goniophotometer. The modifications consisted of adding a receptor lens, a special receptor aperture, and a vacuum holder to keep the specimen flat. The light beam was changed from converging to parallel. The resulting instrument was named the 45° glossmeter. Other instruments for measuring reflected light may be used if they have:

1. A stable light source that projects a beam of light onto the waxed sheet at an angle of 45° to the perpendicular. The light receptor, which contains a receptor aperture and a photocell, is located opposite to the light source, also at an angle of 45° to receive and measure the reflected light. A schematic diagram of an instrument using either a converging or parallel light beam is shown in Fig. 1.
2. Source and receptor apertures that are rectangular in shape and have the following widths in degrees, as seen from the centers of the source lens, test sample, or receptor lens:

Aperture	*In the plane of the beams*	*Across the plane of the beams*
Source	1.0° max.	2.9° max.
Receptor	2.4° ± 0.2°	7.2° ± 0.2°

The width of illumination is defined so that no loss of the desired light rays will occur.

3. A light-measuring mechanism that gives a number proportional to the amount of light passing the receptor aperture.

The 45° glossmeter is first calibrated so that the measuring mechanism reads 97.5 on a black glass having a refractive index of 1.52. This is done by setting the measuring dial at 97.5 and adjusting a supplementary resistance until the galvanometer in the circuit is balanced. The supplementary resistance is adjusted only during calibration.

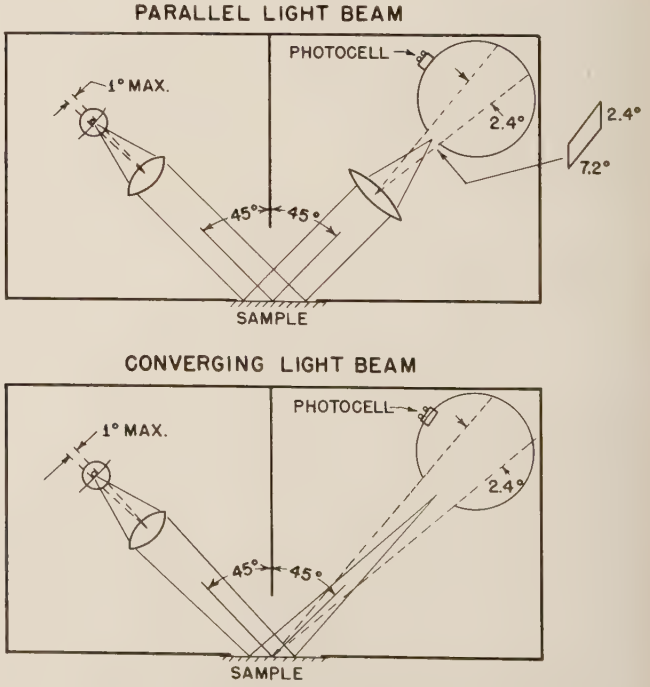

Fig. 1. 45° glossmeter

P. J. GIANACAKES, Research Dept., Standard Oil Co. (Ind.), Whiting, Ind.

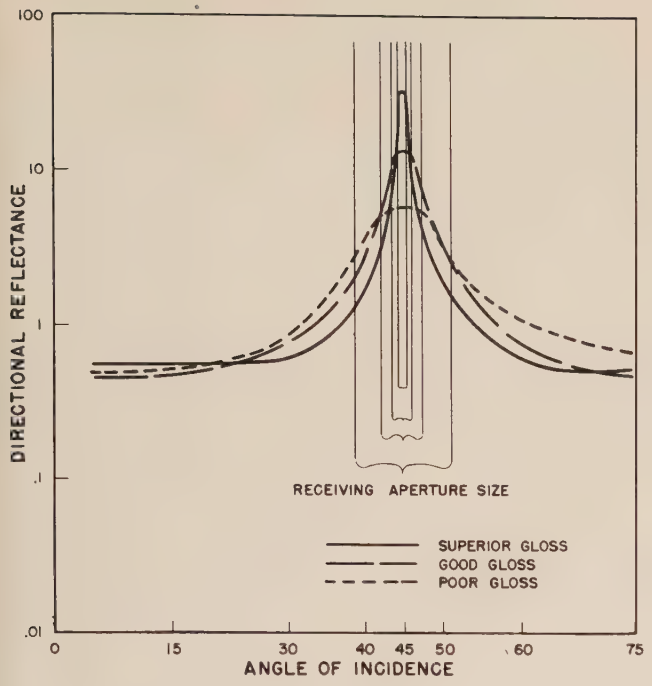

Fig. 2. Waxed paper goniophotometric curves

The waxed paper is next substituted for the black glass, and the galvanometer is again brought into balance by means of the measuring resistance. The specimen is placed on the sample holder with the surface lines of the paper parallel to the plane of the incident and reflected light beams. The position of these lines, which are formed during the coating process, must be fixed with respect to the light beam if repeatable results are to be obtained. The reflectance of the waxed paper can be read directly from the measuring dial since the amount of resistance required to balance the circuit is directly proportional to the light reflected. Three representative specimens from each sample are tested. Readings are in the range of 5 to 50, and are reported to the nearest half unit. Below 10 they are repeatable to 1 unit and above 10 to 2 units.

Readings in the low-gloss range must be corrected because scattered light is being measured along with that specularly reflected. To correct for diffuse reflectance, a reading is obtained with the incident beam perpendicular to the sample and the receiving photocell at 45°. This reading is multiplied by 1.2 and subtracted from the gloss reading. Such a correction can be neglected except when comparing colored with white paper.

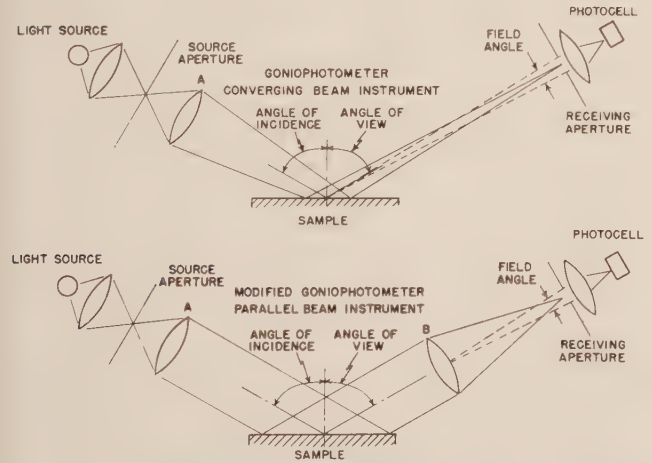

Fig. 3. Modification of goniophotometer to investigate wider range of field angles

DISCUSSION

In developing the new method, optical studies of light reflectance were made with a Hunter goniophotometer (*4*). Use of instruments of this type is well described in the literature (*1*, *3*, *5*, *7–11*). Curves obtained with a poor, good, and superior waxed paper are shown in Fig. 2. Varying the critical dimension of the receptor aperture greatly influences the correlation between instrument and visual gloss. Progressively better distinction between low-gloss samples results as the aperture is enlarged from a narrow slit and more and more of the scattered light is measured. On the other hand, maximum differentiation is obtained between high-gloss samples with a small aperture.

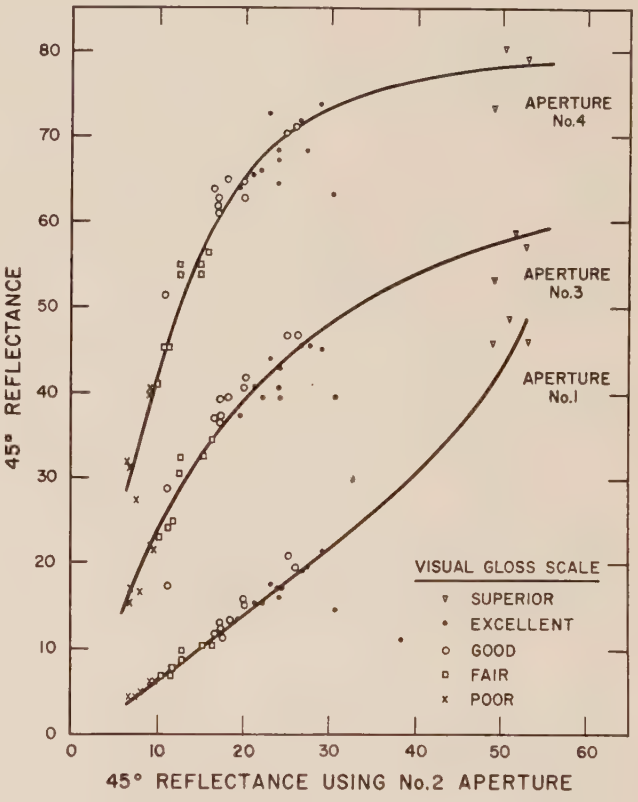

Fig. 4. Effect of receptor aperture at an angle of 45°

In the development of a gloss test to correlate with visual gloss, the effects of both aperature size and angle of specular measurement were investigated. Aperture size was varied at a constant angle of 45°. To investigate a wide range of receptor field angles, the beam of the goniophotometer was changed from converging to parallel. These modifications are shown in Fig. 3. In the original instrument, a converging beam of light is projected to the sample by lens A. This lens is placed at such a distance from the light source that an image is formed at the receptor when the beam is sent uninterruped to this receptor. To convert to a parallel-beam system, lens A is moved back toward the source until the light rays are parallel. Lens B, which is large

enough to pass all the reflected light, focuses this light to form an image on the receiving photocell.

The receptor field angles investigated are shown in Table II. To abtain maximum instrument resolution, a source aperture subtending a field angle of 0.15 by 2.9° was used. The data obtained on the effect of receiving aperture size are plotted in Fig. 4. The best measure of visual gloss is obtained with the no. 2 aperture. At larger field angles, the instrument better differentiates between low-gloss samples than high-gloss samples. At smaller field angles, the opposite is true. The use of no. 4 aperture, which is circular, gives the best measure of gloss in the low range.

The angle of specular gloss measurement was next varied to determine its effect on correlation. Measurements were made at angles of 20, 45, 60, and 75° with the no. 2 aperture. The 20, 60, and 75° data are

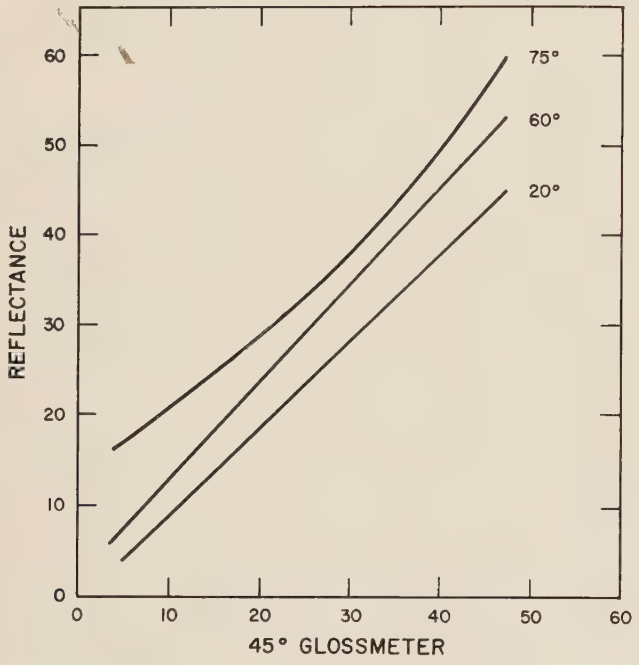

Fig. 5. Effect of angle of measurement using no. 2 aperture

plotted against the 45° data in Fig. 5. The angle of measurement can be varied from 20 to 60° without changing the correlation between instrument and visual gloss established at 45°. This is not true at angles greater than 60°. At 75° the curve shows increased sensitivity in the high-gloss range and decreased sensitivity in the low-gloss range.

Although the data show that any angle from 20 to 60° can be used, a 45° angle was chosen. At smaller angles, variations in reflectance due to irregularities in surface flatness are more pronounced. At larger angles, the sample may show highlights that could give lower sensitivity in the low-gloss range. Even at 45° the sample must be flat to make sure that the instrument measures only light reflected and scattered by the surface. A schematic diagram of the vacuum holder designed for this purpose is shown in Fig. 6.

The 20° ASTM (*12*), 60° ASTM (*13*), and 75° TAPPI (*14*) methods, designed for use on other surfaces, were studied for use on waxed paper. For this

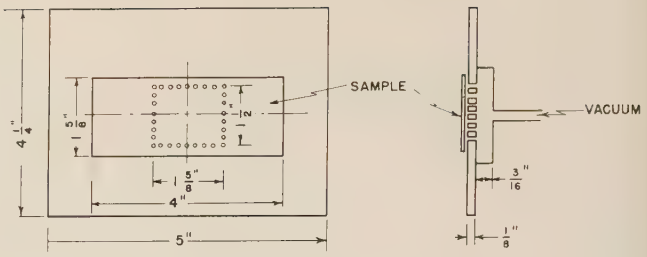

Fig. 6. Sample holder

purpose, the goniophotometer was adjusted to measure 20, 60, and 75° reflectance and the receptor aperture specified in each method was used. The data obtained are compared to the 45° gloss data in Table I and Fig. 7.

The 45° method rated only three samples differently than visual gloss. The other methods rated 6, 9, and 11 samples differently. If instrument values are not in numerical sequence, or if the same number is obtained for samples from two visual categories, they are considered incorrect. The 75 and 60° curves in Fig. 7 show poorer selectivity than at 45° in the high-gloss range. The 20° curve shows higher selectivity in the high-gloss range. While the performance of the 20° method approached that of the 45° method, its use is limited because of the high degree of sample flatness needed to obtain repeatable results. The 45° glossmeter, therefore, gives the best and most precise measure of the gloss of waxed paper.

To aid in gloss evaluation, the following scale re-

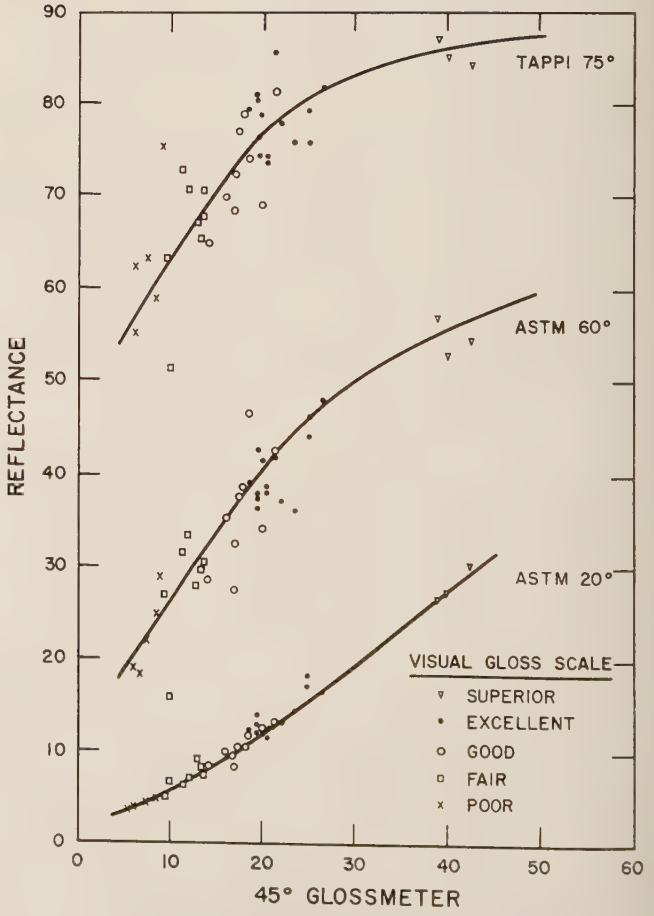

Fig. 7. Comparison of commercial fixed angle glossmeters to 45° glossmeter

Table I. Gloss Measurements on Waxed Paper
(Incorrect values are italicized)

Visual	*45° Gloss*	*20° ASTM*	*60° ASTM*	*75° TAPPI*	*Gonio Gloss Index*
Poor	6.0	4.0	19.0	55.0	5.5
	6.0	4.0	19.0	58.5	5.5
	7.5	4.5	22.0	62.0	6.5
	8.5	5.0	25.0	*63.0*	7.0
	9.0	5.0	*29.0*	*75.0*	*9.0*
Fair	9.5	*5.0*	*16.0*	*51.0*	8.0
	10.0	6.5	27.0	63.0	8.5
	11.5	7.0	28.0	65.0	8.5
	12.0	7.0	29.5	67.0	8.5
	13.0	7.5	30.5	67.5	9.0
	13.5	8.0	30.5	*70.0*	*9.5*
	13.5	8.0	31.5	*70.5*	10.5
	13.5	*9.0*	*33.5*	*72.5*	11.0
Good	14.0	*8.0*	*27.5*	*64.5*	9.5
	16.0	8.5	*28.5*	68.5	12.0
	17.0	9.5	32.5	69.0	13.5
	17.0	10.0	34.0	69.5	13.5
	17.5	10.5	35.0	72.0	14.5
	18.0	10.5	*37.5*	73.5	15.0
	18.5	*11.5*	*38.5*	*76.5*	15.5
	20.0	*12.5*	*42.5*	*78.5*	16.0
	21.5	*13.0*	*46.5*	*81.0*	*35.5*
Excellent	18.5	11.5	36.0	73.5	*13.0*
	19.5	12.0	36.5	74.0	*14.0*
	19.5	12.0	37.0	74.0	16.5
	19.5	12.0	37.5	75.5	17.5
	19.5	13.0	38.0	75.5	18.5
	20.0	13.0	38.0	76.0	19.0
	20.5	13.0	38.5	78.0	22.0
	20.5	13.0	39.0	78.5	22.5
	21.5	13.0	41.5	79.0	24.0
	22.0	14.0	42.0	79.0	25.2
	23.5	14.5	42.5	80.0	25.5
	25.0	16.5	44.0	80.5	27.0
	25.0	17.0	46.0	81.5	35.0
	26.5	18.0	48.0	*85.0*	47.5
Superior	39.0	26.5	53.0	84.0	76.0
	40.0	27.0	54.5	85.0	84.0
	42.5	30.0	57.0	87.0	84.5

lating instrument to visual gloss was set up for the 45° method. These average numbers were obtained by taking into consideration the repeatability of measurements.

Instrument values,°	*Visual gloss*
Above 35	Superior
20 to 35	Excellent
15 to 20	Good
10 to 15	Fair
Below 10	Poor

The 45° glossmeter results were also compared to results obtained from goniophotometric curves. These curves were appraised in terms of the Gonio Gloss Index:

$$\frac{R_{45}}{(R_x - R_o) + (R_y - R_o)}$$

where R_{45} is the reflectance at 45°, R_x is the average reflectance from 0 to 40°, R_y is the average reflectance from 50 to 75°, and R_o is the reflectance at 0°. These data are compared in Table I and Fig. 8. The Gonio Gloss Index curve shows that this instrument is better than the 45° gloss test for differentiating samples in the superior range. Its ability to differentiate between samples of low gloss, however, is poorer. The Gonio Gloss Index is particularly valuable because it gives the best measure of the high-gloss waxed papers desired today.

Table II. Field Angles of Receptor Apertures

	Aperture no. 1	2	3	4
In the plane of the light beam	1.8°	2.4°	4.5°	11.5°
Across the plane of the light beam	1.6°	7.2°	11.5°	11.5°
Shape of aperture	Rectangular	Rectangular	Rectangular	Circular

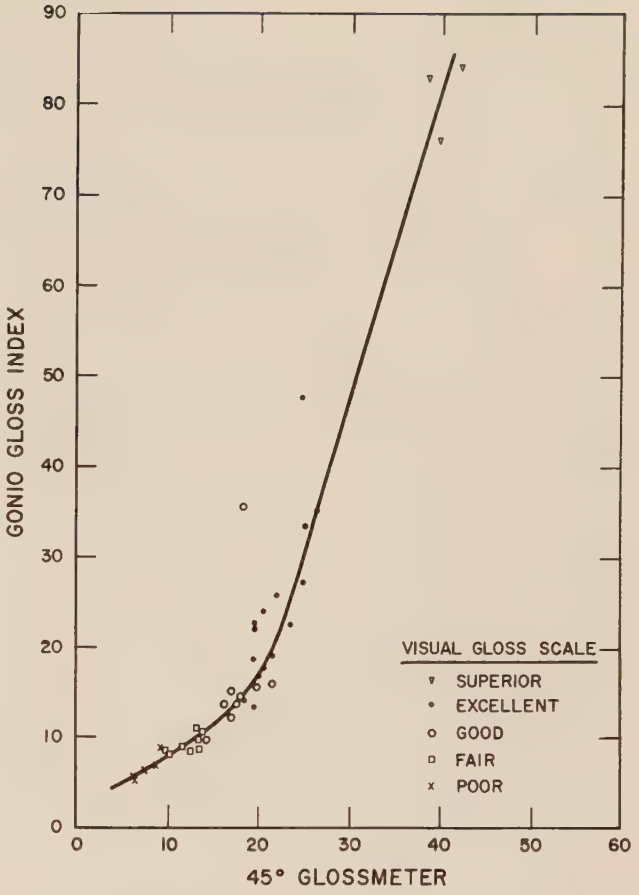

Fig. 8. Comparison of Gonio Gloss Index to 45° glossmeter

The author wishes to acknowledge the guidance, assistance, and encouragement given by the late F. H. MacLaren. Appreciation is extended to M. W. Kane of Kalamazoo Vegetable Parchment Co. for supplying the waxed papers, to R. S. Hunter of Hunter's Associates Laboratory for his assistance in the use and adaptation of the goniophotometer, and to M. D. Gambril for help in carrying out this work.

LITERATURE CITED

1. Chester, C. A., *Brit. Paper and Board Makers' Assoc., Proc. Tech. Sect.* 32: 813 (1951).
2. Harrison, V. G. W., *J. Sci. Instr.* 26: 84(1949).
3. Harrison, V. G. W., *J. Sci. Instr.* 24: 21 (1947).
4. Hunter, R. S., "A New Goniophotometer and Its Application," presented before Optical Society of America, New York, N. Y., March 11, 1950.
5. Hunter, R. S., and Judd, D. B., *ASTM Bull.* 97: 11 (1939).
6. Hunter, R. S., *ASTM Bull.* 44: 72 (1948).
7. Hunter, R. S., *J. Res., Nat. Bur. Standards* 18: 19 (1937).
8. Hunter, R. S., *ASTM Bull.* 186: 48 (1952).
9. Jones, L. A., *J. Opt. Soc. Am.* 6: 140 (1922).
10. Moon, P., and Laurence, J., *J. Opt. Soc. Am.* 31: 130 (1941).
11. Westlaufer, L. A., and Scott, W. E., *Ind. Eng. Chem., Anal. Ed.* 12: 647 (1940).
12. *Am. Soc. Testing Materials, Proc.* 51: 287 (1951).
13. *Am. Soc. Testing Materials,* "A.S.T.M. Standards," Part 4, p. 441 (1949).
14. TAPPI Tentative Standard, T 480 m-51, *Tappi* 34: 87A (1951).

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Gas Adsorption by Wood, Pulp, and Paper

I. The Low-Temperature Adsorption of Nitrogen, Butane, and Carbon Dioxide by Sprucewood and Its Components

WILLIAM R. HASELTON

The nature of the low-temperature adsorption of nitrogen, butane, and carbon dioxide on specimens of sprucewood, chlorite holocellulose, and KOH-extracted chlorite holocellulose was investigated. The apparatus and procedures used in obtaining adsorption isotherms are described. The Brunauer, Emmett, and Teller, Harkins-Jura, and Fu-Bartell methods of computing surface area from adsorption data are outlined and the utility of each method for application to nitrogen and butane adsorption measurements on cellulosic materials is discussed. Although nitrogen and butane are only physically adsorbed, carbon dioxide appears to dissolve in the noncellulosic constituents of extracted sprucewood and to be strongly adsorbed by wood cellulose. It was concluded that nitrogen adsorption measurements and the Brunauer, Emmett, and Teller method of computing surface area constitute the best combination for area studies on pulp and paper.

It is generally recognized that a strong interrelationship exists between the external surface area of pulp fibers and many of the properties of both the pulp itself and the paper into which it is made. The external specific surface, in addition to being a measure of the potential area of the fibers available for bonding, markedly influences the drainage characteristics and is closely related to the ability of pulps to retain dyes, sizing materials, and beater additives. In paper, the exposed surface or the unbonded area influences a number of properties such as opacity, reflectance, and porosity. The bonded area of paper, on the other hand, is probably the most important single factor contributing to the strength of the sheet.

It is not surprising, therefore, that considerable attention has been given to area characteristics of pulp and paper. In the past few years, microscopic, solute adsorption, permeability, surface catalytic, and optical methods have been employed to estimate the external specific surface of pulp fibers with varying degrees of success. In combination, these last two methods also provide the only practical way which has been available for estimating the bonded area of paper. Most of the work which has been done in this field has dealt with or has made use of the wet external surface area of the pulp. Little attention has been given to the dry external specific surface of the fibers or to the direct measurement of the bonded and unbonded area of paper. A method which suggests itself for such area measurements involves gas adsorption. Although the several studies of the adsorption of gas by wood, pulp, cotton, and paper which have been made were not detailed, they indicated that gas adsorption techniques may provide a valuable tool for the investigation of the area and structure of dry pulp fibers and paper.

Before these applications of gas adsorption can be undertaken, it is necessary that the nature of the adsorption process be thoroughly understood for, if gaseous adsorption data are to be of use for such studies, it is essential that only physical adsorption occur. This is imperative since, if the gas combines chemically, is absorbed, or alters the original condition of the pulp or paper, it is of little value for area and structure investigations. Therefore, it was the aim of the initial portion of the present work to study the nature of the adsorption of several of the more promising gases—i.e., nitrogen, butane, and carbon dioxide near their normal liquefaction (or solidification) temperature on extracted sprucewood and its major components. From the shape of the adsorption and desorption isotherms, equilibrium and area considerations, and the thermodynamics involved, sufficient information was made available to evaluate the usefulness of gas adsorption techniques for area and structure studies and to determine the suitability of each gas for use with cellulosic materials.

PREVIOUS STUDIES OF THE ADSORPTION OF NITROGEN AND CARBON DIOXIDE BY CELLULOSIC MATERIALS

Although the adsorption of nitrogen and carbon dioxide by wood, cotton, pulp, and paper has been investigated to some extent, the adsorption of butane by cellulosic materials does not appear to have been studied.

Employing gravimetric means, Grace and Maass (*1*) found that, at 22°C., sprucewood sorbed 1.1% carbon dioxide at pressures of 42 cm. of mercury and above. The sorbed gas was readily removed on evacuation. When cotton was the adsorbent, no sorption could be detected. Salley (*2*), using a more sensitive volumetric technique, found that cotton adsorbed measurable quantities of carbon dioxide and determined a number of points on isotherms at 0 and 100°C. When he studied the takeup of carbon dioxide on beaten bleached sulphite pulp, however, it was found that, whereas adsorption equilibrium was reached after a period of days at 80 and 56°C., it could not be obtained even after prolonged exposure at 0°C.

Stamm (*3*) found that sprucewood adsorbed nitrogen in the amount of 0.02 ml. per gram at 25°C. and 760 mm. of mercury pressure. The other reported studies of nitrogen adsorption on cellulosic materials were made at liquid nitrogen temperatures (−196°C.) and were carried out mainly to permit calculation of accessible surface area. Assaf, Haas, and Purves (*4*) determined

WILLIAM R. HASELTON, Graduate Student, The Institute of Paper Chemistry, Appleton, Wis.

the area of caustic-swollen, benzene-dried cotton linters in this way. Hunt, Blaine, and Rowen (*5*) determined nitrogen isotherms and from these the area of both benzene-dried and water-dried cotton. Rowen and Blaine (*6*) computed the change in free surface energy occurring when nitrogen was adsorbed on cotton. As part of a study of the effect of fiber size and shape on their papermaking properties, Haywood (*7*) measured the surface area of hardwood ray cells dried from water or acetone using nitrogen adsorption. Emmett and DeWitt (*8*) studied the adsorption of nitrogen on paper of a type used to insulate telephone cable, and determined the accessible surface area.

THE DETERMINATION OF SURFACE AREA FROM GAS ADSORPTION DATA

Early successful efforts by Brunauer and Emmett (*9–11*) to utilize low-temperature adsorption data for the measurement of surface area involved an empirical method for selecting the point on the adsorption isotherm (and, therefore, the volume of gas) corresponding to the completion of a monolayer of adsorbed gas molecules. When a value was assigned for the average area covered by each adsorbed molecule, a calculation of the area of the adsorbent exposed to the gas was possible.

Brunauer, Emmett, and Teller (*12*) gave increased validity to the use of adsorption isotherms for area measurements by the development of a theory of multimolecular adsorption based on Langmuir's (*13*) treatment of unimolecular adsorption. The Brunauer, Emmett, and Teller (B.E.T.) theory makes it possible to plot the adsorption data in such a way as to obtain mathematically the volume of gas required to form a monolayer on a given adsorbent. The most useful form of the B.E.T. equation is

$$p/v(p_0 - p) = 1/v_m c + [(c - 1)/v_m c]\ p/p_0 \qquad (1)$$

where v is the volume of adsorbed gas in milliliters (S.T.P.) per gram of adsorbent at pressure p in millimeters of mercury at a temperature at which the vapor pressure of the gas is p_0; v_m is the volume of gas in milliliters (S.T.P.) per gram of sample required to form a monolayer, and c is a constant. A plot of the left-hand side of equation (1) against the relative pressure (p/p_0) usually gives a straight line for relative pressures between 0.05 and 0.30. From the slope and intercept of this plot, the monolayer volume (v_m) can be readily evaluated. Multiplication of the number of gas molecules corresponding to v_m by the cross-sectional area of each molecule as indicated by equation (2) gives the area of the solid accessible to the gas in square meters per gram.

$$\text{Area} = \frac{N v_m L}{22{,}400 \times 10^{20}} \qquad (2)$$

where N is Avogadro's number and L is the molecular cross-sectional area in square angstroms of the gas being used.

Harkins and Jura (*14*) have developed a method of determining specific surface from gas adsorption data which does not require an estimation of molecular area. The Harkins-Jura equations do not formulate a new theory of adsorption but are rather a modified expression of the fact that the same empirical equations relating surface pressure to the average area per molecule that have been shown to apply to insoluble films on water also appear to apply to physically adsorbed films of gases on solids. The relationship can be expressed by the equation

$$\log (p/p_0) = B - A/v^2 \qquad (3)$$

where A and B are constants, v is the volume in milliliters (S.T.P.) adsorbed per gram of adsorbent, and (p/p_0) is the relative pressure. When $\log (p/p_0)$ is plotted against the reciprocal of the square of the adsorbed volume, a linear relationship is frequently obtained at lower relative pressures. The area of the solid in square meters per gram is given by the equation

$$\text{Area} = kA^{0.5} \qquad (4)$$

where A is the slope at lower pressures of a plot of equation (3) and k is a constant whose value for nitrogen was originally determined by Harkins and Jura using the area of titanium dioxide powder obtained by a method involving the measurement of the heat of immersion in water. In applying this equation to the measurement of the areas of other solids, the assumption is made that the compressibility of the adsorbed film is unaffected by the nature of the solid and, for a given gas and temperature, the k for one adsorbent is the same as the k for another. At the present time, this method is limited somewhat in that k has been evaluated for only a few gases including nitrogen ($k = 4.06$) and krypton at -195.8°C., butane ($k = 13.6$) at 0°C., and heptane and water at 25°C.

Recently, Fu and Bartell (*15*) reported a method for area measurements of porous solids based on the total change of free surface energy occurring during the adsorption of gas. This change is easily computed from isotherm data using a modification of an equation derived by Boyd and Livingston (*16*). This modified equation is

$$a\varphi = \frac{RT}{V} \int_0^p (v/p)dp \qquad (5)$$

where R is the gas constant, T the absolute temperature, V the molar volume of the gas, p the equilibrium pressure of the adsorbed gas, and v the volume (S.T.P.) adsorbed per gram of specimen. The total change in free surface energy is equal to the product of the change in the free surface energy per unit area φ and a, the area per gram of solid. If, for porous materials, $a\varphi$ is plotted against relative pressure p/p_0, a "break" frequently occurs in the curve which is thought to indicate the appearance of liquid adsorbate in the pores. Fu and Bartell obtained the area of the solid from

$$a = (a\varphi_s - a\varphi_x)/\gamma_{lv} \qquad (6)$$

where $a\varphi_s$ is the total change in free surface energy at the saturation pressure and $a\varphi_x$ is the similar change at the relative pressure corresponding to the "break" mentioned above. The term γ_{lv} is the surface tension of the condensed gas at the temperature of the adsorption.

EXPERIMENTAL EQUIPMENT AND PROCEDURES

Apparatus for the Determination of Adsorption Isotherms

The volumetric apparatus employed to determine adsorption isotherms is similar to that originally used

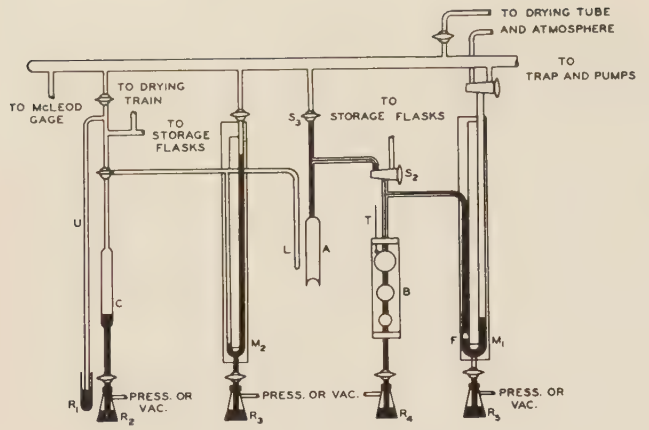

Fig. 1. Apparatus for determination of adsorption isotherms

by Harkins and Jura (*14*). Its operation is based on the principle that, if the pressure of the gas in a buret of known volume is measured before and after adsorption on a material is allowed to take place, the quantity of gas adsorbed at the final pressure can be determined. A schematic drawing of the equipment is given in Fig. 1.

The main vacuum header extending across the top of the apparatus is connected at one end through a dry ice–alcohol cold trap to the pumps and at the other to a McLeod gage. Pressures of 10^{-4} mm. of mercury are obtained using a silicone oil diffusion pump backed by a Megavac rotary oil pump. The sample to be studied is sealed in bulb A and connected to the apparatus by 1-mm. capillary tubing. The gas buret B of approximately 150 ml. volume is surrounded by a water jacket equipped with thermometer T. The buret is connected by 2-mm. tubing to manometer M_1. The right-hand leg of the manometer is 850 mm. in length and is constructed, as is the lower portion of the left-hand leg, of a single piece of 12-mm. glass tubing. Mercury for M_1 and the other manometer and bulbs is stored in reservoirs R_1 to R_5. All but R_1 can be connected to either vacuum or 10 p.s.i. nitrogen when desired. The three-way stopcock S_2 permits the gas buret and the left-hand leg of M_1 to be connected either to the adsorption bulb or to the storage flasks. Four flasks, each of 3-liter capacity, contained the various gases under a pressure not exceeding 900 mm. of mercury. The compression chamber C and the tube leading to the manometer M_2 (8-mm. tubing) are filled with the gas whose adsorption isotherm is to be determined. When the gas is compressed by filling C with mercury, the vapor condenses into a liquid in tube L which is immersed in the same bath as the adsorption bulb. The saturated vapor pressure of the liquid is read on M_2. Barometric leg U was included to prevent the pressure in the system from exceeding 900 mm. of mercury when the storage flasks were being filled.

Pretreatment of Gases

The nitrogen, butane, carbon dioxide, and helium used in the experimental work were of the highest purity commercially obtainable in cylinders. The helium, which is not measurably adsorbed at temperatures above −200°C., was employed to determine the volume of the adsorption bulb not occupied by adsorbent (so-called "dead space"). The carbon dioxide and nitrogen were dried by passage through a dry ice–alcohol cold trap and a drying train containing anhydrone and phosphoric anhydride. In addition, the helium was passed over activated charcoal at −78°C. The butane was not passed through the cold trap but, after drying, was purified by liquefaction and evaporation, with rejection of the first third of the distilling gas.

Preparation of Adsorption Samples

Since the nature of the adsorption of nitrogen, butane, and carbon dioxide could not be determined separately on the components of sprucewood *in situ*, the work which was done was concerned with the low-temperature adsorption of these gases on extracted sprucewood, sprucewood from which lignin had been removed by treatment with acidified sodium chlorite solution, and this chlorite holocellulose after further treatment with alkali to remove hemicelluloses. These adsorbents were prepared in the following manner: portions of five peeled sticks of Canadian-grown black spruce (*Picea mariana*), having an average diameter of 6 in. and age of 75 years, were reduced to sawdust, air dried, and ground in a Wiley mill. Only the fraction passing a 40-mesh and retained by a 60-mesh U. S. Standard screen was used. The wood meal was extracted for 3 days with a mixture of alcohol and benzene and, after air drying, with distilled water at 95°C. for 2 hr. A portion of the air-dried extracted sprucewood was subjected to sodium chlorite oxidation, employing large-scale equipment similar to that used by Barton (*17*). The chlorite holocellulose was finally air dried after a thorough washing with distilled water. To effect the removal of hemicelluloses, part of the chlorite holocellulose was extracted under nitrogen with 5% potassium hydroxide following the method of Wise, Murphy, and D'Addieco (*18*). A lignin-free yield of chlorite holocellulose of 78% and of caustic-extracted chlorite holocellulose of 58% (based on the extracted wood) was obtained. Analysis of these materials for apparent pentosans (TAPPI Standard T 223 m), Klason lignin (TAPPI Standards T 13 m and T 222 m), and alpha-cellulose (TAPPI Standard T 203 m) are reported in Table I.

To increase the total surface area available for adsorption and, thereby, the precision of the adsorption measurements, each of the samples was ground in a Wiley mill to pass a 120-mesh screen. After thorough drying, the adsorbents were placed in adsorption bulbs constructed by connecting about 6 in. of 1-mm. capillary tubing to the base of a 28-mm. test tube. The open end of the bulb was closed by pressing in approximately 2 in. of the sawed-off base of a 25-mm. test tube until the rims were flush and fusing the rims together.

Measurement of Adsorption Isotherms

The procedure involved in obtaining isotherm data will be considered, assuming that nitrogen is the adsorbate. Reference should be made to Fig. 1 in following the discussion. After adsorption bulb A was sealed to the apparatus, S_3 and the other connections to the vacuum header were opened and the system was evacuated for 12 to 18 hr. All open stopcocks were then closed and mercury was run up into manometers M_1

and M_2. Liquid nitrogen, contained in a wide-mouth vacuum flash, was placed around adsorption bulb A, and helium was admitted through stopcock S_2 until the pressure in the gas buret was 200 to 300 mm. As was done before each pressure measurement, the left-hand leg of manometer M_1 was adjusted to mark F and the pressure read to the nearest 0.1 mm. with a cathetometer. The temperature of the water jacket was recorded to the nearest 0.1°C. with thermometer T at this and all subsequent pressure measurements. By turning stopcock S_2, the helium was allowed to expand into the adsorption bulb. The mercury levels in the manometer changed and, when equilibrium was reached, the pressure was again determined. Since the helium is not adsorbed but merely fills the space around the sample, these measurements permitted determination of the "dead space." For an excellent description of the calculations involved in computing the "dead space" and adsorbed gas volumes, reference should be made to an article by Bugge and Kerlogue (*19*).

The low-temperature bath was removed, the mercury in M_1 pulled down into the reservior, and the entire right side of the apparatus evacuated for several hours. Stopcocks S_2 and S_3 were then closed, and the adsorption bulb and tube L were immersed in liquid nitrogen. Nitrogen was admitted to the compression bulb C, tube L, and the left-hand side of manometer M_2. As the compression bulb was filled with mercury from R_2, the nitrogen was liquefied in the end of L and its saturated vapor pressure was measured to the nearest 0.5 mm. Mercury was allowed to rise in manometer M_1, a small quantity of nitrogen was admitted through S_2, and the pressure was read. The gas was allowed to expand into the adsorption bulb, and after equilibrium was reached (5 to 15 min.), the pressure was again determined. Stopcock S_2 was then adjusted to admit an additional small amount of nitrogen and the above procedure was repeated until the desired number of points on the adsorption isotherm were obtained. When nitrogen was the adsorbate, the volume of gas (S.T.P.) adsorbed at each equilibrium pressure is given by

$$V_a = V_t - V_h\,(1 + \alpha p/760) - V_b \qquad (7)$$

where V_a is the total volume of gas adsorbed, V_t is the volume of adsorbate that is initially in the buret system, V_h is the volume of the adsorbate required to fill the "dead space" to p (the equilibrium pressure), α is the correction factor to account for the deviation of nitrogen from the perfect gas laws at −196°C., and V_b is the volume of the gas remaining in the buret when adsorption equilibrium has been reached. It should be noted, however, that equation (7) must be modified when using butane or carbon dioxide since, in addition to V_h, both V_t and V_b must be corrected for the imperfection of these gases at room temperature.

Table I. Analysis of Adsorption Samples

	Extracted sprucewood	*Chlorite holocellulose*	*5% KOH-extracted chlorite holocellulose*
Apparent pentosans, %	9.7	10.8	5.0
Klason, lignin, %	27.9	4.2	1.4
Alpha-cellulose, %	50.4[a]	61.8	84.4

[a] Determined from yield data and the alpha-cellulose content of the chlorite holocellulose.

Table II. External Specific Surface of the KOH-Extracted Chlorite Holocellulose as Determined from Nitrogen and Butane Adsorption Isotherms

	Assumed adsorbate molecular area, sq. A	*Adsorbent surface area, sq. m. per gram*	*Assumed adsorbate molecular area, sq. A.*	*Adsorbent surface area, sq. m. per gram*
B.E.T. method	16.2	1.06	32.1	0.98
	15.6	1.02	34.8	1.06
Harkins-Jura method	..	1.02	..	1.00
Fu-Bartell method	..	0.81	..	..

Deviation of Butane from the Perfect Gas Laws

Values of the correction factor α in equation (7) for nitrogen, carbon dioxide, and butane at several different temperatures have been calculated by Emmett and Brunauer (*10*) from literature data. Although no difficulty was experienced in the case of nitrogen and carbon dioxide, when the reported factors were employed in determining the first butane isotherm, the desorption points fell increasingly above the adsorption curve in a manner entirely different from that observed for a hysteresis loop. It was speculated that this might be due to an accumulating error in computing the volume of gas in the buret at each pressure. Therefore, it was thought desirable to check the correction factors for butane (at 760 mm.) of 3.2% at 25°C. and 10.8% at 0°C. which were determined by Emmett and Brunauer (*10*) from work reported by Dana, Jenkins, Burdick, and Timm (*20*). Pressure-volume studies were made with butane at 23, 0, and −21.2°C., and calculations were carried out to determine the average values of the correction factor α which best fit the experimental data. These were found to be 2.7% at 23°, 5.0% at 0°, and 6.0% at −21.2°C. It would appear that the correction factors reported in the literature by Brunauer and Emmett are somewhat high. Therefore, the values as experimentally determined, were employed throughout the present work and were found to be satisfactory.

NITROGEN AND BUTANE ADSORPTION ON SPRUCEWOOD, CHLORITE HOLOCELLULOSE, AND KOH-EXTRACTED CHLORITE HOLOCELLULOSE

Isotherms for the adsorption of nitrogen and butane on KOH-extracted chlorite holocellulose are given in Fig. 2. Since the isotherms and the results in general were essentially the same for the sprucewood and the chlorite holocellulose, they will not be discussed in detail. To maintain the constant temperatures required during the runs, liquid nitrogen (−195.7°C.) and liquid oxygen (−182.9°C.) were used with nitrogen, and cracked ice and the sodium chloride-ice eutectic (−21.2°C.) were employed with butane. The major portion of the work was concerned with the adsorption of nitrogen at −195.7°C. and butane at 0°C. Isotherms at the other temperatures were measured solely to furnish the data necessary for computation of the differential heats of adsorption. The isotherms for nitrogen at −195.7°C. and butane at 0°C. are of the typical S-shaped type common for the adsorption of these gases near their liquefaction temperatures. The shape of the curves and the fact that the desorption

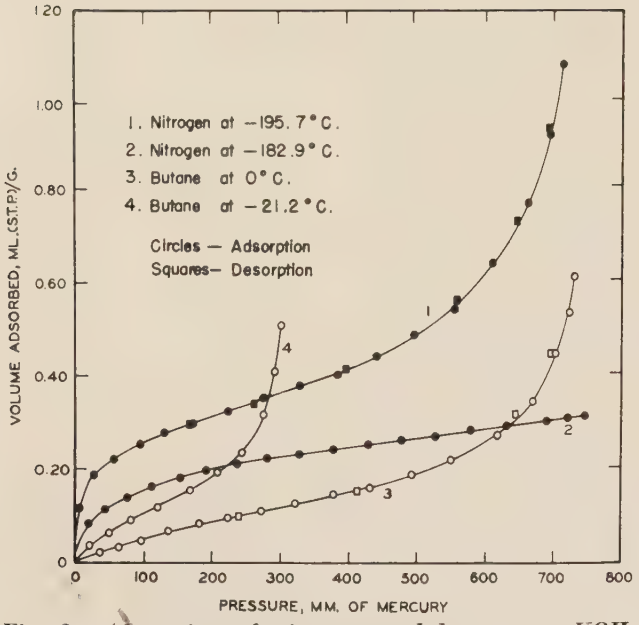

Fig. 2. Adsorption of nitrogen and butane on KOH-extracted chlorite holocellulose

points fell on or quite close to the adsorption curves indicate that the adsorbent is essentially nonporous.

Determination of External Specific Surface

A B.E.T. plot for nitrogen adsorption on the sprucewood, chlorite holocellulose, and KOH-extracted chlorite holocellulose is given in Fig. 3. Similar plots of the Harkins-Jura and Fu-Bartell equations are given in Figs. 4 and 5, respectively. Since the plots for the adsorption of butane on the three materials are much the same in appearance, they are not included. Estimates of the external specific surface of the sample of KOH-extracted chlorite holocellulose which were determined by the B.E.T., Harkins-Jura, and Fu-Bartell methods from nitrogen and butane adsorption data are given in Table II. The B.E.T. areas were calculated using molecular cross-sectional areas of 16.2 sq. A for nitrogen and 32.1 sq. A for butane as suggested by Emmett and Brunauer (*10*) and also assuming slightly different molecular areas. The absence of a clear-cut "break" in the Fu-Bartell plot of butane adsorption on KOH-extracted chlorite holocellulose prevented an area calculation in this case.

From Table II it is seen that the Harkins-Jura areas are essentially the same whether computed from nitrogen or butane adsorption data. For nitrogen adsorption, the check between the B.E.T. and Harkins-Jura areas is best if a molecular cross-sectional area of 15.6 sq. A instead of 16.2 sq. A is assumed. This is similar to the findings of Harkins and Jura (*14*) that for over 100 samples of different adsorbents studied, a nitrogen molecular area of 15.4 sq. A gave the "best fit" between their technique and the B.E.T. method. However, there is no assurance that the Harkins-Jura method gives the more accurate area values. That is to say, whereas a molecular area of 15.6 sq. A may give the best agreement between the B.E.T. and the Harkins-Jura areas on cellulosic materials, the use of 16.2 sq. A for nitrogen with the B.E.T. method may very well give a result closer to the actual external specific surface of the solid. Using 32.1 sq. A as the area of an adsorbed butane molecule, a fair check was obtained for the area measured by the B.E.T. and the Harkins-Jura methods. A molecular area for butane of 34.8 sq. A must be assumed, however, to obtain a specific surface in agreement with the nitrogen (16.2 sq. A) B.E.T. area. This is not the first indication that the area value of 32.1 sq. A originally suggested for butane may be low. Russell and Cochran (*21*) studied the adsorption of butane on alumina and concluded that the correct area of an adsorbed butane molecule is 39 sq. A, whereas Livingston (*22*) stated that 44.6 sq. A is the "best value" for the area of these molecules. The present work suggests that approximately 35 sq. A is the most satisfactory cross-sectional area to be employed for butane when the adsorbent is wood or other cellulosic material. The area obtained from the nitrogen adsorption data using the Fu-Bartell method is considerably lower than the area determined by the other methods; for butane adsorption no area could be computed. This is no reflection on the validity of the Fu-Bartell method which appears to be fundamentally sound but merely demonstrates that a technique based on the assumption that the adsorbent is highly porous could not be successfully used to measure the area of nonporous materials.

Thermodynamics of the Adsorption of Nitrogen and Butane

The decrease in the free surface energy ($-\Delta F$) and the differential heat of adsorption (ΔH) for the adsorption of butane and nitrogen on KOH-extracted chlorite holocellulose are plotted in Fig. 6. Similar plots were obtained for the sprucewood and chlorite holocellulose. The change in free surface energy was

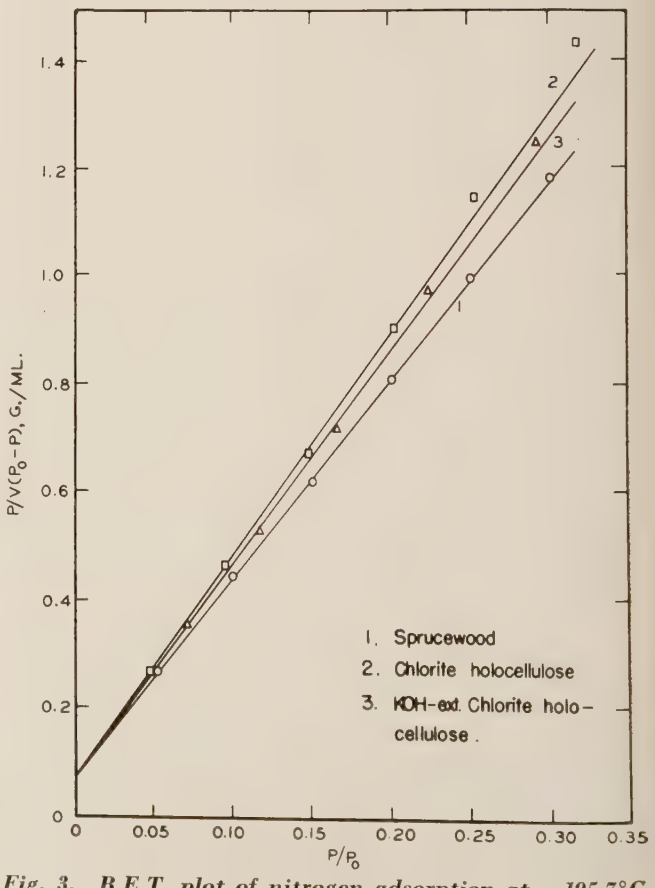

Fig. 3. B.E.T. plot of nitrogen adsorption at −195.7°C.

Table III. Decrease in Free Surface Energy for the Adsorption of Nitrogen and Butane on Cellulosic Materials

Relative pressure, p/p_0	$-\Delta F$ ergs per sq. cm. 0.20	0.50	0.80
Nitrogen			
Sprucewood	22.0	30.8	37.0
Chlorite holocellulose	22.1	30.8	37.0
KOH-ext. chlorite holocellulose	22.4	30.8	36.9
Butane			
Sprucewood	8.2	17.4	25.9
Chlorite holocellulose	7.4	16.0	23.9
KOH-ext. chlorite holocellulose	7.5	16.5	25.2

obtained by dividing the total change value determined from equation (5) by the area of the adsorbent computed from nitrogen adsorption data by the B.E.T. method (molecular area—16.2 sq. A). The integration, which was carried out graphically, necessitated an extrapolation to zero pressure. Harkins and Jura (*23*) have stated that the correct value of this integral can be obtained only if experimental points are determined down to a relative pressure of 0.001. These necessary low-pressure data were measured and used in conjunction with the regular isotherms to evaluate the decrease in free surface energy. Values of this function at three arbitrarily selected relative pressures are given in Table III. For nitrogen adsorption, the decrease in free surface energy was almost exactly the same on the three adsorbents. A decrease of approximately 28 ergs per sq. cm. at a relative pressure of 0.40 obtained in the present study is somewhat greater than the decrease of 20 ergs per sq. cm. found at this relative pressure by Rowen and Blaine (*6*) for the adsorption of nitrogen on cotton. This difference would not appear to be due to any difference in the nature of the adsorption but rather that Rowen and Blaine did not take the necessary adsorption measurements at very low relative pressures. The change in free surface energy with the adsorption of butane was quite similar for all three materials although somewhat less uniformity may be noted than in the case of nitrogen adsorption. In general, the adsorbed gas film was not appreciably influenced by changes in the chemical composition of the adsorbents.

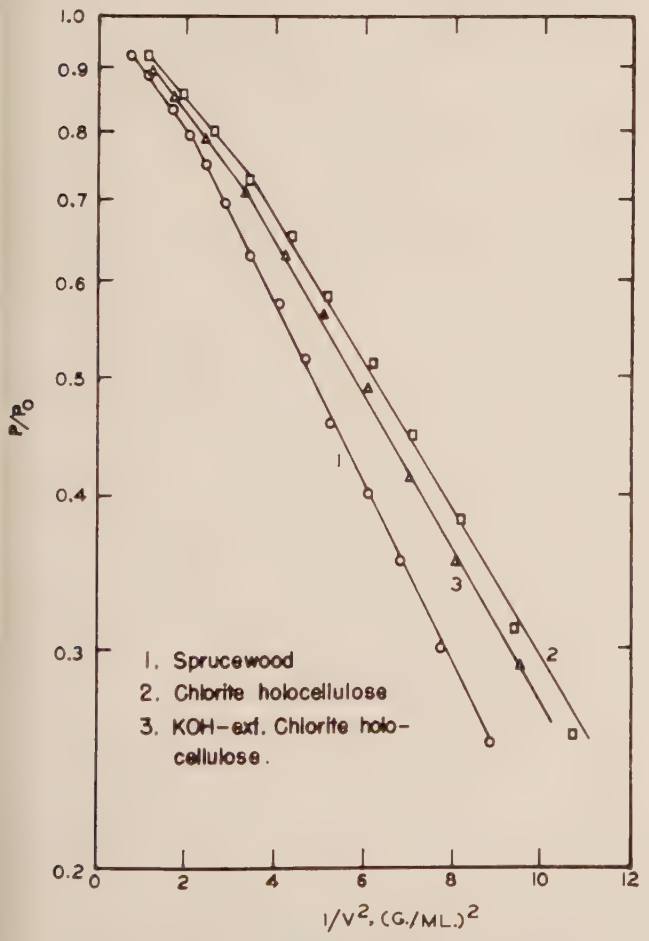

Fig. 4. Harkins-Jura plot of nitrogen adsorption at −195.7°C.

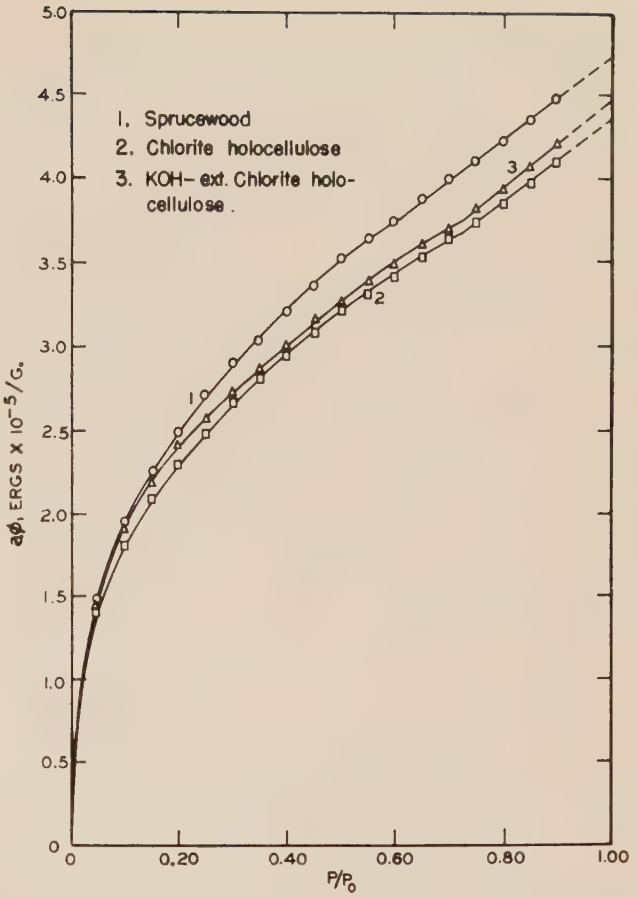

Fig. 5. Fu and Bartell plot of nitrogen adsorption at −195.7°C.

Differential heats of adsorption have been calculated by the Clausius-Clapeyron equation from nitrogen isotherms measured at −195.7 and −182.9°C. and from butane adsorption at 0 and −21.2°C. These values were plotted against v/v_m, the relative portion of the surface of the adsorbent occupied by adsorbed molecules, where v_m was computed by the B.E.T. equation. The heat curves do not decrease smoothly and occasionally show humps probably due to variations in submicroscopic structure. As v/v_m increases, however, the differential heat of adsorption in all instances approaches E_L, which in this case is the average heat of liquefaction of the particular adsorbate at the two temperatures employed. The shape of the curves and the computed values of the differential heat of adsorption supported the previous indications that only physical adsorption of the nitrogen and butane occurred on the sprucewood, chlorite holocellulose, and KOH-extracted chlorite holocellulose.

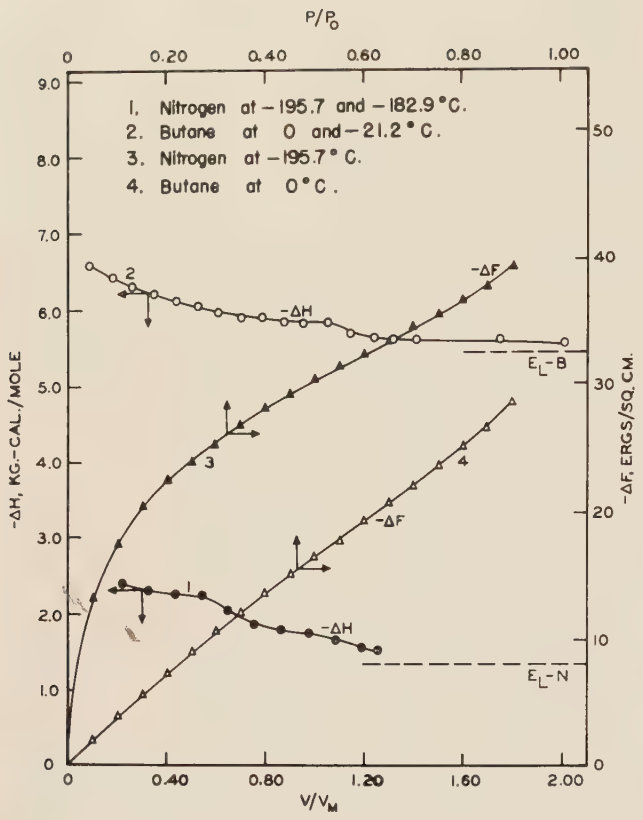

Fig. 6. Thermodynamic functions for nitrogen and butane adsorption on KOH-extracted chlorite holocellulose

EQUILIBRIUM STUDIES WITH CARBON DIOXIDE AT −78.6°C.

Early in the initial attempt to determine an isotherm for the adsorption of carbon dioxide on sprucewood at −78.6°C. (dry ice–ethyl ether bath), it was noted that equilibrium was not quickly reached as had been the experience with nitrogen and butane. Therefore, a series of equilibrium studies were undertaken of the sorption of carbon dioxide by sprucewood, chlorite holocellulose, KOH-extracted chlorite holocellulose, the precipitated hemicelluloses removed on caustic extraction, and a sample of spruce native lignin. After being sealed in sample bulbs and thoroughly evacuated, the various materials were exposed to carbon dioxide at −78.6°C. and the pressure of the gas in the buret was measured periodically. All pressure readings were corrected to 25°C. and plotted against the logarithm of time in Fig. 7. Pressure equilibrium was reached in 10 to 15 min. when the adsorbent was KOH-extracted chlorite holocellulose but it was not obtained for the other materials even after 2 to 3 days' exposure. The sorption appears to be reversible, for when a rerun was made on the sprucewood and chlorite holocellulose following evacuation, the original equilibrium curves were essentially duplicated. Therefore, although the takeup of carbon dioxide on the sprucewood and chlorite holocellulose did not come to equilibrium, treatment of these materials to remove most of the noncellulosic constituents resulted in a high-cellulose product on which adsorption equilibrium was quickly reached. The continued sorption of gas by the samples of isolated hemicelluloses and native lignin also indicate that carbon dioxide is more than physically adsorbed on the noncellulosic materials in wood. These results are similar to those of Salley (*2*) previously discussed where, at low temperatures, carbon dioxide sorption came to equilibrium on cotton but not on bleached sulphite pulp. Upon consideration of the various possible sorption processes, it was concluded that the observed prolonged takeup of carbon dioxide could result from either a chemisorption of the gas by the lignin and hemicelluloses, a solution in these materials, or the continuing alteration of the exposed surface of the adsorbent by the gas. To check the possibility that a chemical reaction occurred, measurement was made of the rate of sorption of carbon dioxide on sprucewood at −78.6 and 0°C. Use was made of these rate data to calculate the energy of activation of the sorption process using a modified Arrhenius equation suggested by Taylor and Williamson (*24*). An initial value of approximately 2 kg.-cal. per mole was obtained. Since this is considerably lower than the values of activation energy generally associated with a chemical reaction, it must be concluded that chemisorption did not take place. The possibility of the carbon dioxide acting to continually expose new internal area does not appear likely since a redetermination of the area of evacuated sprucewood with nitrogen after exposure to carbon dioxide shows the area to be exactly the same as for the original material. Brunauer (*25*) has stated that a long continued takeup of gas is due usually to a solution in the solid rather than to adsorption alone. From the lack of evidence of chemisorption or area alteration and from the fact that the sorbed carbon dioxide appears to be largely removed on evacuation, it is believed that just such a prolonged

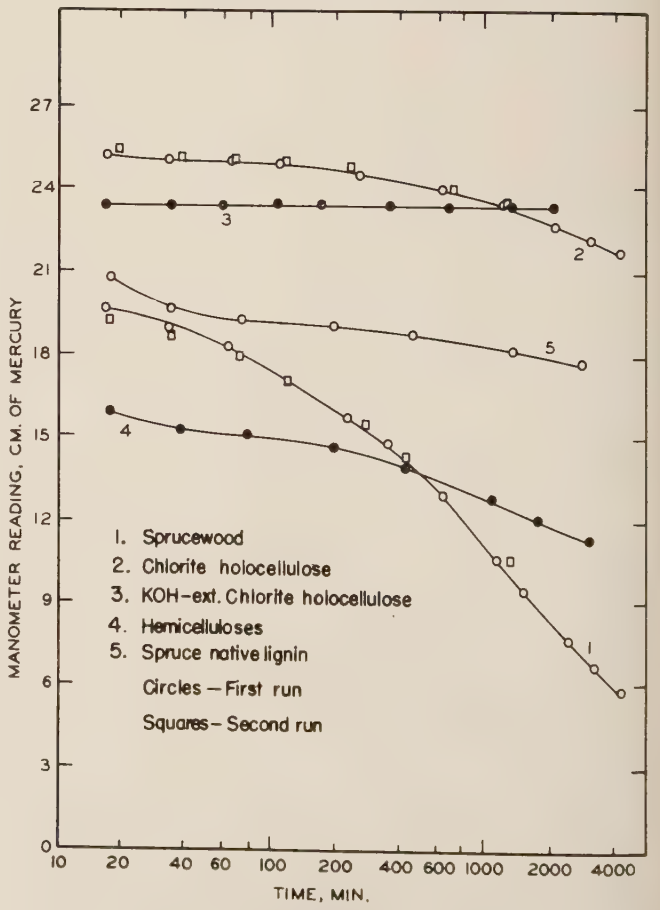

Fig. 7. Equilibrium studies with carbon dioxide at −78.6°C.

solution of carbon dioxide may have occurred in the noncellulosic constituents of sprucewood. Only when the lignin and hemicelluloses had been largely removed was the solution of gas decreased to a point where essentially only physical adsorption took place and equilibrium was quickly reached.

ADSORPTION OF CARBON DIOXIDE ON KOH-EXTRACTED CHLORITE HOLOCELLULOSE

Isotherms for the absorption and desorption of carbon dioxide on KOH-extracted chlorite holocellulose at −78.6°C. are given in Fig. 8. Also included is an isotherm at −89.3°C. (liquid ethane bath) employed in determining the differential heat of adsorption. Since the second adsorption-desorption run at −78.6°C. is essentially the same as the first, it would appear that a complete removal of the adsorbed carbon dioxide occurred on evacuation. However, in contrast to the isotherms obtained with nitrogen and butane, the desorption isotherm is at no point identical with the adsorption curve. This large hysteresis loop suggests that there is a somewhat stronger attraction between the adsorbed carbon dioxide molecules and the solid than existed for the other gases.

When the cross-sectional area of an adsorbed carbon dioxide molecule was determined that would give the same area for the KOH-extracted chlorite holocellulose as that measured by the B.E.T. method using nitrogen adsorption (molecular area—16.2 sq. A), a value of 28.3 sq. A was obtained. This area is somewhat higher than a molecular area of 20 sq. A reported by Livingston (*22*) for carbon dioxide adsorbed on porous glass and silica gel and may also be the result of a greater attraction between the carbon dioxide and the cellulose than exists for inorganic materials.

Decrease in free surface energy determined from the isotherm measured at −78.6°C., and differential heat of adsorption values computed from the −78.6 and 89.3°C. data are plotted in Fig. 9. Although the change in free surface energy curve is somewhat similar to those for butane and nitrogen, the curve for the differential heat of adsorption involved relatively high heats (7 to 10 kg.-cal. per mole) for the first quantities of gas adsorbed. Since the energies generally associated with hydrogen bonds are 5 to 10 kg.-cal, per mole (*26*), it is possible that these high initial differential heats and the observed large hysteresis loop may have resulted from hydrogen bonding occurring between the oxygens of the adsorbed carbon dioxide molecules and the uncombined cellulosic hydroxyl groups. Even small amounts of such bonding would not be desirable in a gas to be used for area studies for the various methods of computing area from isotherm data are based on the assumption that only simple physical adsorption is occurring. Although the average heat of adsorption of the first adsorbed layer of gas molecules involved heats suggestive of solid carbon dioxide, as the quantity of adsorbed gas increased, the differential heat leveled out at a value somewhat lower than the average heat of sublimation (E_s) for carbon dioxide at the two temperatures involved. This may be an indication that the carbon dioxide molecules adsorbed in the second and higher layers exist in a state corresponding more closely to a liquid than a solid.

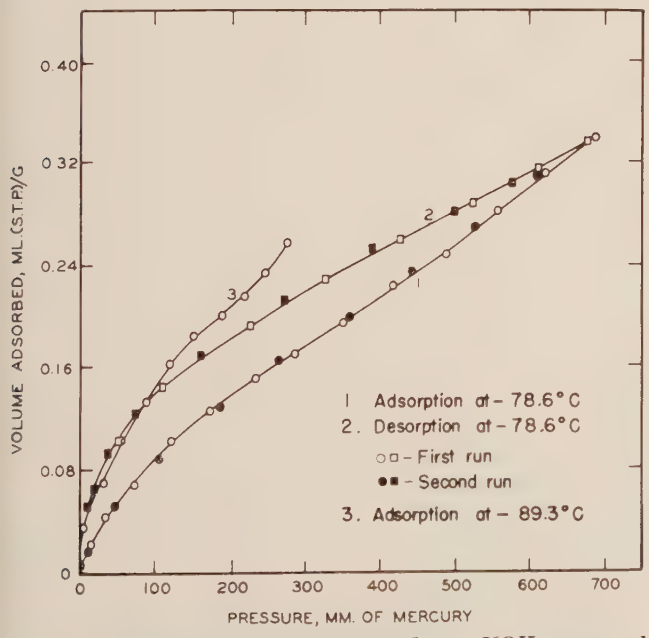

Fig. 8. Adsorption of carbon dioxide on KOH-extracted chlorite holocellulose

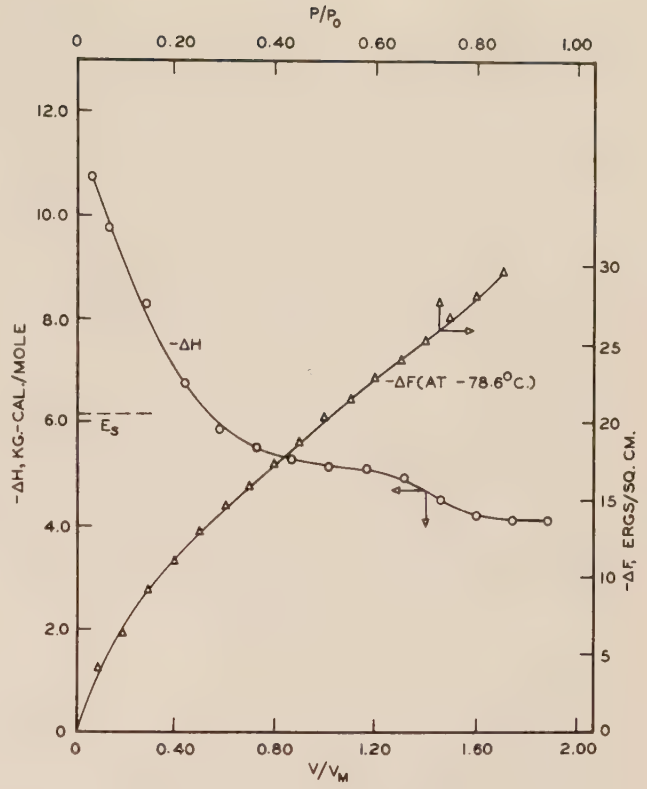

Fig. 9. Thermodynamic functions for carbon dioxide adsorption on KOH-extracted chlorite holocellulose at −78.6 and −89.3°C.

SUMMARY

It has been shown that the nature of the adsorption of both butane and nitrogen on sprucewood and its major components is such that either gas can be used for area measurements on cellulosic materials. Carbon dioxide, however, appears to be soluble in the noncellulosic constituents of wood and for this reason not suitable for area studies when these materials are present. Even on fairly pure cellulose, where equilibrium adsorption is quickly reached, carbon dioxide is not to be recommended for area measurements since isotherm and differential heat considerations indicate that a moder-

ately strong attraction such as hydrogen bonding of the adsorbed gas molecules may be occurring. Of the two gases, nitrogen has several advantages over butane. The smaller, more spherical molecules of nitrogen have an area which is more definitely known. Nitrogen does not require correction for deviation from the perfect gas laws at room temperature, and also it generally gives adsorption measurements and area plots having better precision.

Both the B.E.T. and the Harkins-Jura methods of computing surface area have been found to give satisfactory results when applied to adsorption data measured on cellulosic materials. In actual practice, however, the B.E.T. method is more desirable to use since it yields better straight-line plots and requires the measurement of fewer points on the adsorption isotherm than does the Harkins-Jura method. It appears that nitrogen adsorption measurements and the B.E.T. method of computing area constitute the best combination for area studies on pulp and paper using gas adsorption techniques.

LITERATURE CITED

1. Grace, N. H., and Maass, O., *J. Phys. Chem.* 36: 3046–3063 (1932).
2. Salley, D. J., *Textile Research* 5: 493–508 (1935).
3. Stamm, A. J., *J. Phys. Chem.* 33: 398–414 (1929).
4. Assaf, A. G., Haas, R. H., and Purves, C. B., *J. Am. Chem. Soc.* 66: 66–73(1944).
5. Hunt, C. M., Blaine, R. L., and Rowen, J. W., *J. Research Natl. Bur. Standards* 43: 547–554(1949).
6. Rowen, J. W., and Blaine, R. L., *Ind. Eng. Chem.* 39: 1659–1663(1947).
7. Haywood, G., *Tappi* 33, No. 8: 370–383(Aug., 1950).
8. Emmett, P. H., and DeWitt, T. W., *Ind. Eng. Chem., Anal. Ed.* 13: 28–33(1941).
9. Brunauer, S., and Emmett, P. H., *J. Am. Chem. Soc.* 57: 1754–1755(1935).
10. Emmett, P. H., and Brunauer, S., *J. Am. Chem. Soc.* 59: 1553–1564(1937).
11. Brunauer, S., and Emmett, P. H., *J. Am. Chem. Soc.* 59: 2682–2689(1937).
12. Brunauer, S., Emmett, P. H., and Teller, E., *J. Am. Chem. Soc.* 60: 309–319(1938).
13. Langmuir, I., *J. Am. Chem. Soc.* 38: 2221–2295(1916).
14. Harkins, W. D., and Jura, G., *J. Am. Chem. Soc.* 66: 1366–1373(1944).
15. Fu, Y., and Bartell, F. E., *J. Phys. Colloid Chem.* 55: 662–675(1951).
16. Boyd, G. E., and Livingston, H. K., *J. Am. Chem. Soc.* 64: 2383–2388(1942).
17. Barton, J. S., *Tappi* 33, No. 10: 496–503(Oct., 1950).
18. Wise, L. E., Murphy, M., and D'Addieco, A. A., *Paper Trade J.* 122, No. 2: 35–43(Jan. 10, 1946); *Tech. Assoc. Papers* 29: 210–218(1946).
19. Bugge, P. E., and Kerlogue, R. H., *J. Soc. Chem. Ind.* 66: 377–381T(1947).
20. Dana, L. I., Jenkins, A. C., Burdick, J. N., and Timm, R. C., *Refrigerating Eng.* 12: 387–404(1926).
21. Russell, A. S., and Cochran, C. N., *Ind. Eng. Chem.* 42: 1332–1335(1950).
22. Livingston, H. K., *J. Colloid Sci.* 4, No. 5: 447–485(Oct., 1949).
23. Jura, G., and Harkins, W. D., *J. Am. Chem. Soc.* 66: 1356–1362(1944).
24. Taylor, H. S., and Williamson, A. T., *J. Am. Chem. Soc.* 53: 2168–2180(1931).
25. Brunauer, S., "The Adsorption of Gases and Vapors," vol. 1, 511 pages, Princeton, Princeton University Press, 1945.
26. Schmidt, A. X., and Marlies, C. A., "Principles of High Polymer Theory and Practice," 743 pages, especially Chap. 2, New York, McGraw-Hill, 1948.

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Problems in the Evaluation of Caustic Absorbency of Pulp Sheets

RICHARD W. SWINEHART and ALBERT T. MAASBERG

Problems arising from the variable caustic absorbency of pulp sheets when dipped continuously in caustic solutions to produce alkali cellulose are discussed. The process is briefly outlined with respect to its mechanical nature and its flexibility in regard to the production of alkali celluloses having a wide range of caustic contents. The main variables are the control of the uniformity of physical properties within the roll and from roll to roll. The process depends upon uniform sheet formation which is evaluated by visual inspection of the sheet under diffused light. Other physical properties such as basis weight, caliper, density, porosity, water absorbency, and special caustic absorbency tests are discussed and interpretations of results are given as they apply to this process. Additional physical properties such as bursting and tear strength are included to further define sheet requirements.

The quality of cellulose derivatives is dependent to a large extent on the uniformity of the alkali cellulose from which they are prepared. This is especially true in the case of cellulose ethers. The quality of the alkali cellulose, in turn is highly dependent on the uniformity of the wood pulp or cotton linters sheet.

The yield of cellulose ethers is largely dependent on the purity or alpha-cellulose content of the chemical pulp from which they are prepared. In addition to the available cotton linters pulp, several wood pulps have come into production during recent years which have high alpha-cellulose contents, in excess of 95%, and low caustic solubility. Chemically, these wood pulps have proved to be equivalent to cotton linters pulps.

In a continuous dip process for the production of alkali cellulose, such as is used by The Dow Chemical Co. and some other cellulose derivative manufacturers, the uniformity of the pulp sheet, insofar as caustic absorbency is concerned, is of extreme importance. A number of problems have been encountered in the study of several different methods for the evaluation of the caustic absorbency which have led to a better understanding of the basic concepts involved.

Before discussing the methods of evaluation and the problems which have arisen, it would be well to de-

Richard W. Swinehart, Director of Research, and Albert T. Maasberg, Manager, Cellulose Products Dept., The Dow Chemical Co., Midland, Mich

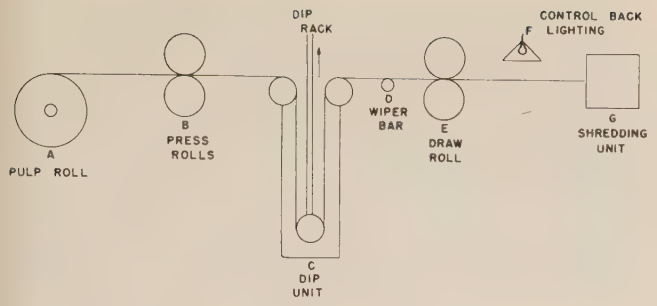


Fig. 1. Alkali cellulose unit

scribe, in some detail, the alkali cellulose process involved (Fig. 1).

The pulp, in the form of rolls, is placed on the stand A and threaded through the system to draw rolls E. The machine is then started up and the dip rack C is lowered to such a depth that complete penetration of the sheet with NaOH is obtained. This is controlled by wiper bar D, visual inspection lights at F, and titration of the per cent NaOH in the sheet. The pulp sheet is then broken up by passing through a continuous shredder. The press rolls B are used as needed to regulate NaOH pickup. The effect obtained here will be discussed later.

The drive on this unit has a wide range of speed and is automatically regulated by the lead unit which increases or decreases the speed as needed. Shrinkage or elongation is controlled by dancer rolls spaced at central points.

When operating at a pulp speed of 130 lineal f.p.m., dipping time varies between a minimum of about 1.1 to a maximum of about 3.0 sec., which necessitates the exacting requirements for uniformity of sheet and caustic absorption properties.

Figure 2 illustrates to some degree the flexibility of the unit in the production of alkali cellulose over a wide range of caustic concentrations.

By choosing the proper caustic concentration in the dip pan, within the range of 14 to 80% NaOH, it is possible to prepare alkali cellulose with the proper NaOH and water to cellulose ratios, which upon reaction with the proper chemicals, will satisfactorily produce many different cellulose derivatives.

Alkali cellulose prepared under the conditions outlined by areas one and two will produce organo-soluble ethylcellulose; area three will produce water-soluble methylcellulose; area four will produce alkali-soluble methylcellulose. An alkali cellulose having the composition used in the production of viscose is illustrated by area five.

The calculated area of caustic, water, and cellulose (water from dip NaOH only) covered by the application of this continuous unit to the production of carboxymethylcellulose by the double dip process has been outlined in area six.

A study of the various areas readily indicates the concentration of caustic which will be required to produce a specific cellulose derivative. The next step is to select a pulp sheet with the correct physical properties to give the desired caustic and water to cellulose ratios.

Further control of the above ratios may be made on the unit by pressing the sheet before dipping in caustic and by variations in the temperature of the bath and the speed of the sheet.

The over-all problem which faces both the derivative manufacturer and the pulp supplier is to gain knowledge of the chemical and physical properties of the sheet, their effect on the quality of the product, and means of testing for these properties.

Unfortunately, it is still necessary to actually process the pulp all the way through to a cellulose derivative product to be sure of its final utility. An attempt will now be made to present evaluations of various physical tests which it is hoped will aid a manufacturer of pulp to meet the needs of a particular process.

SHEET FORMATION

Uniformity

The first, and the most important, physical property to consider is the uniformity of sheet formation. Figure 3 shows visually the good uniformity of sheet formation which is desired. A quick screening test may be made by back lighting the sheet with a strong light. There are commercially available cotton linters pulps which will pass this test, however, only a few experimental wood pulps have been found which are satisfactory.

Figure 4 illustrates the type of nonuniformity which is not desired as indicated by the many light and dark areas. Most commercial wood pulps, unfortunately, show up as being unsatisfactory in this test.

A good sheet of the type shown in Fig. 3, after processing in caustic, has the appearance indicated by Fig. 5. Swelling is uniform and the sheet is still relatively free of light and dark areas when held against diffused light.

When a poor sheet of the type shown in Fig. 4 is processed in caustic a very nonuniform appearing sheet (Fig. 6), as indicated by the uneven swelling (pock marks), is obtained. Upon tearing this sheet in such a manner as to expose a maximum area of the interior of the sheet, the dark or dense areas of the sheet are observed to be not completely impregnated with caustic. In some cases this is visible to the eye since the areas with no caustic are white while the surrounding areas have the characteristic color of alkali cellulose. The addition of an indicator, Tropaeolin O (Na 2, 4 dihydroxyazo benzene, 4 sulphonate) (saturated solution

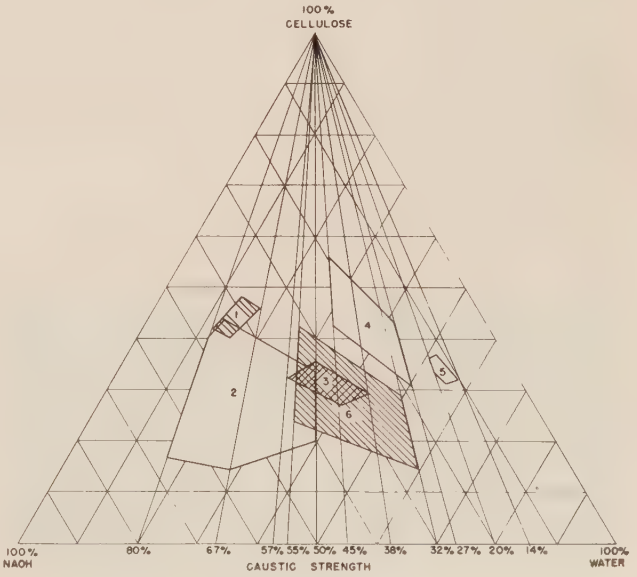


Fig. 2. Alkali cellulose composition

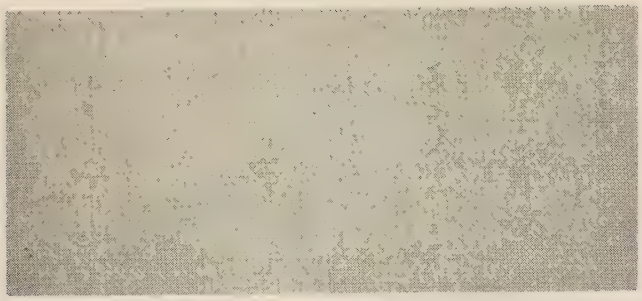


Fig. 3. Uniformity of sheet formation

in acetone), which is yellow at a pH of 11 and red at a pH of 12.8, to the exposed section of the torn sheet gives a distinctive color effect. The red areas are impregnated with caustic while the yellow portions are not.

The results of this test must be used with some caution since these light and dark areas may be, in some cases, simply due to a poor sheet formation. In addition, the test results may vary because of differences in density and sheet thickness.

Physical Properties

Effect of Variables in High Alpha-Cellulose Production. Early work upon the effect of the alpha-cellulose content of wood pulps was conducted to determine what effects pretreatment by hydration might have upon dipping properties. In these early experiments, 95% alpha-cellulose wood pulp was treated with caustic to obtain several higher alpha-cellulose samples. These pulps were beaten to various freeness values, and handsheets were tested for apparent density* (grams per cubic centimeter) and porosity (Gurley, 300 cc. air—three sheets). As would be expected, the higher alpha pulps required longer beating to reach any given freeness which indicates that freeness is developed in higher alpha pulps more by cutting than by hydration. They also produced (Fig. 7) less dense sheets at the same freeness since the shrinkage of hydrated fiber on drying is probably a major factor in the development of density.

An interesting observation made in this work was that the log of the porosity readings bore a straight-line relationship to the density for all of the sheets in this series (Fig. 8) in spite of the varying combinations of cutting and hydration used. This would seem to indicate that both density and porosity are influenced primarily by one of the factors in beating, probably the hydration effect. Further work along this line might aid in establishing hydration to cutting relationships for different beating techniques.

The plot of freeness versus porosity (Fig. 9) shows

* Density (grams per cubic centimeter) = basis weight in grams per square foot/caliper in inches by 2631.

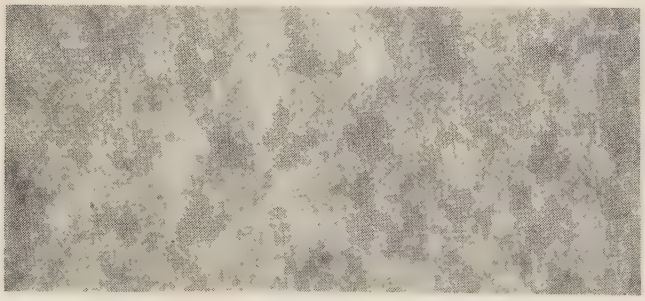


Fig. 4. Nonuniformity of sheet formation

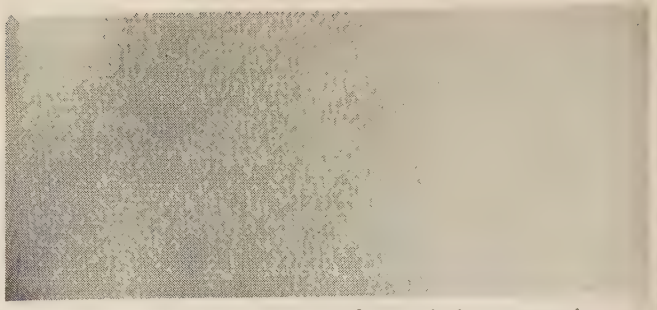


Fig. 5. Good Uniformity of caustic impregnation

the effect of alpha or porosity more clearly than the density-porosity curve. As freeness decreases, log of porosity increases, the rate being slightly less at lower freenesses. Decreasing alpha content of pulp greatly decreases porosity, the effect being most pronounced at lower freeness.

When these sheets were dipped in caustic, it was found that all of them, when completely penetrated, absorbed more than the desirable amount of caustic for efficient etherification.

The heavily beaten highest alpha pulp most nearly approached the desired caustic content in a reasonable dipping time.

Effect of Physical Properties—Caliper, Basis Weight, Density, and Porosity. Some commercial linters pulps have satisfactory properties such as caliper, basis weight, density, and porosity.

Upon dipping in 50% or weaker caustic these pulps will give satisfactory caustic contents. However, other linters pulps and practically all usable wood pulps require mechanical pressing when dipped in stronger than 50% caustic to regulate the caustic absorption.

The best of these pulps will have a density of 0.42 to 0.49 gram per cc., and a porosity of 10 to 30 sec. and a preferred range of basis weight of 40 to 45 grams per sq. ft. with a caliper of 0.040 to 0.045 in.

Effect of Mechanical Pressing. To study the effect of mechanical pressing upon caustic absorbency, the group of typical commercial pulps listed in Table I was selected because they varied from one another in such properties as basis weight, caliper, density, and porosity. These pulps were then pressed to the calipers indicated and the porosity and density were determined. The different pulps are labeled with letters K through S and are arranged in the order of decreasing utility.

The two pulps K and L have the physical sheet properties which, upon mechanical pressing of the sheet, will give acceptable uniformity of caustic pickup.

Pulps M through S represent other experimental pulps having somewhat similar physical properties which have been tested. The physical properties of

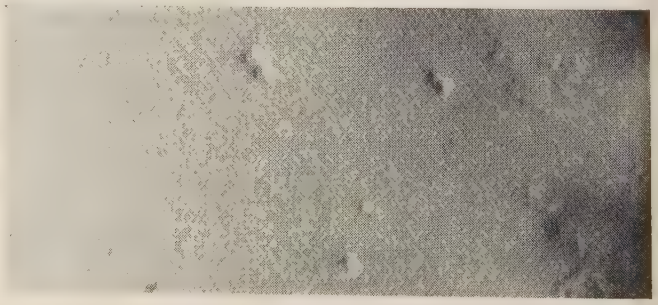


Fig. 6. Dipped sheet—poor uniformity of caustic impregnation

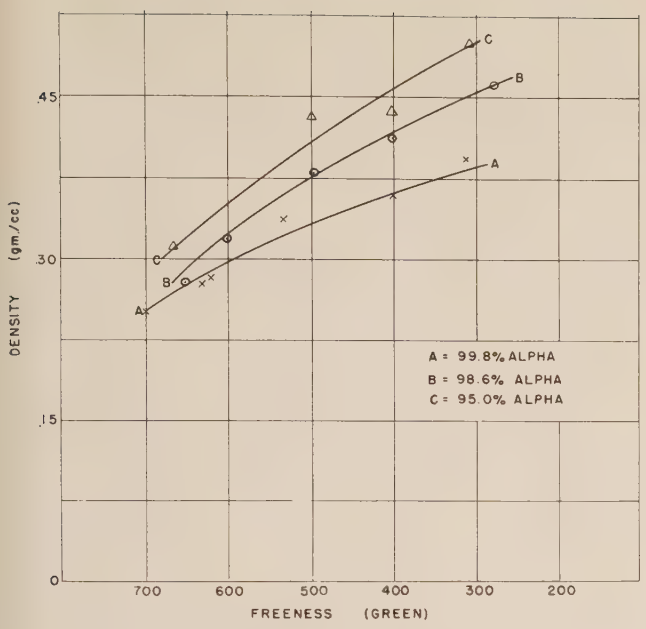


Fig. 7. Effect of alpha content (NaOH treatment) on beating-density relationship

the pulp M indicated that it should be penetrated by caustic satisfactorily and, upon dipping, this was found to be the case. However, when a supposedly duplicate sheet N was prepared, it was found upon processing that an unsatisfactory caustic pickup was obtained. The pulp N has physical properties similar to K, L, and M except that the Gurley porosity of N was found to be considerably higher, 78 sec. and upon compression to 0.025 in. had increased to 363 sec. These data may indicate that the fiber of pulp N had been hydrated more than that of the original pulp M which has a Gurley porosity of 15 sec.

The pulp P illustrates the effect obtained when a pulp similar to pulp R is wet pressed to adjust the basis weight and caliper to correspond to pulps K through N. The density (0.610 gram per cc.) and the porosity (43 sec.) of the unpressed sheet were high. Upon pressing to 0.025 in. caliper, this pulp was found to have an acceptable porosity of 90 sec. and a density of 0.830 gram per cc. The wild sheet formation, however, made this pulp sheet unsatisfactory.

The pulp R, while having satisfactory density and porosity, was high in basis weight and caliper. A pulp of this type is very difficult to process by pressing even if it has good sheet uniformity. If the sheet is pressed lightly enough to give the density and porosity indicated by pulps K and L, it is impossible to obtain the proper caustic content.

The pulp S has an acceptable caliper of 0.047 in. and Gurley porosity (10 sec.) and is included to illustrate the effect pressing has upon high basis weight (60 grams per sq. ft.) and high density (0.540 gram per cc.). Upon pressing to 0.025 in. caliper this pulp has a Gurley porosity of 279 sec. and gave an unsatisfactory caustic content similar to pulp R.

A plot of porosity versus density of these pulps (Figure 10) has been made showing the porosity and density values originally and then after pressing to 0.033 and 0.025 in. caliper.

In general the curves for most of the pulps have approximately the same slope except for those for pulps P, N, and S. Pulps K, L, and M, when pressed to 0.025 in. caliper, give satisfactory caustic pickup. The pulp R would possibly fall in this group if the basis weight was lowered with the proportional reduction in caliper. The curves for pulps N and S indicate that some form of hydration of the fiber occurred before sheeting that was not desirable. In the case of pulp P it was definitely known that densification was accomplished by wet pressing of the sheet and this fact is reflected by the slope of its curve. Further study of pulps in regard to the slope of their porosity versus density curves may make it possible to evaluate variables in fiber processing before sheeting.

WATER ABSORBENCY

The water absorbency of the sheeted pulp is measured

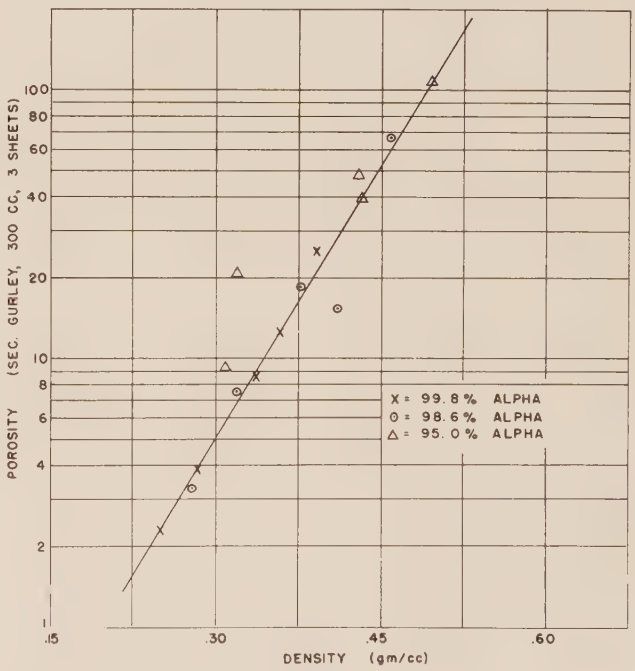


Fig. 8. Density versus porosity

Table I. Effect of Dry Pressing on Properties

Pulp	Basis weight, g./sq. ft.	Original sheet: Caliper, in.	Original sheet: Density, g./cc.	Original sheet: Gurley[a] porosity, sec.	Pressed 0.033 in.: Density, g./cc.	Pressed 0.033 in.: Gurley[a] porosity sec.	Pressed 0.025 in.: Density g./cc.	Pressed 0.025 in.: Gurley[a] porosity, sec.
K	43.2	0.042	0.437	11.5	0.550	21	0.740	87
L	43.0	0.042	0.435	10.6	0.515	19.5	0.720	52
M	43.0	0.041	0.440	15.0	0.550	34	0.710	109
N	46.0	0.044	0.440	78.0	0.590	131	0.780	363
P[b]	49.0	0.035	0.610	43.0	0.595	79	0.830	90
R	55.0	0.054	0.430	12.0	0.645	62	0.930	265
S	60.0	0.047	0.540	10.0	0.776	44	0.860	279

[a] Gurley porosity—300 cc. air through three sheets.
[b] Densified by wet pressing before drying.

by the time required for the liquid to travel by capillary action a distance of $4^1/_2$ in. up a strip of pulp $^5/_8$ in. wide and 6 in. long.

This test has been used to considerable extent in the belief that the results have some bearing upon the ability of a pulp to absorb caustic. To date, it has not been found to be fully trustworthy.

If the water absorbency goes below 300 sec., the pulp sheet is usually too weak to be processed successfully.

A preferred range of 400 to 600 sec. has been established on pulp having a basis weight of 41 to 46 gram per sq. ft. and an apparent density range of 0.420 to 0.490 gram per cc. The range of caliper, by necessity, is quite narrow and in the sheeting operation it should be adjusted to give an average density of 0.450. gram per cc. at each individual basis weight.

While mechanical pressing changes the density and Gurley porosity of acceptable pulps, it does not change the rate of water absorbency to any great extent. There are, however, indications that the water absorbency on acceptable pulps varies directly with porosity of the unpressed pulp.

NaOH ABSORBENCY

Another test of caustic absorbency is the measurement of the ability of a pulp sheet to absorb droplets of 50% NaOH. This is accomplished by measuring the time in seconds required for a drop of 50% caustic to be completely absorbed into the surface of a pulp sheet. The range for satisfactory linters sheet is 7 to 12 sec. while that for most wood pulp sheets will be from 20 to over 100 sec. In most cases, it has been found that the lower the number of seconds required for the drop to disappear, the better the impregnation. Mechanical pressing will undoubtedly affect the rate of impregnation but as also indicated under water absorbency, the differences have never been measured too successfully.

Several attempts to adapt the water absorbency procedure to measure caustic absorbency have not proved successful. This test could prove to be very

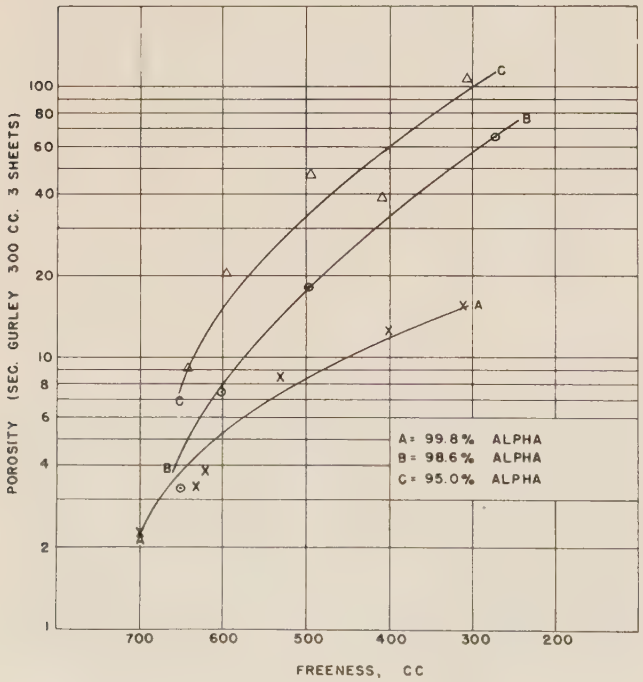


Fig. 9. Freeness versus porosity

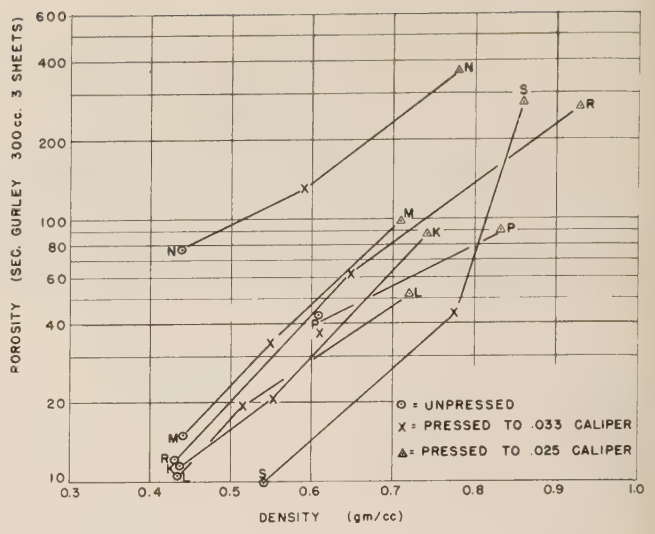


Fig. 10. Effect of dry pressing on density and porosity

valuable and it may be possible to obtain better correlation of results as the many physical properties which have been discussed are better understood.

BURST AND TEAR STRENGTH

Pulp sheets having a bursting strength of 55 ± 10 lb. per sq. in. have been found to be satisfactory. Weaker sheets have been troublesome as far as caustic wet strength is concerned.

The dry strength of acceptable pulp sheets as measured by the Elmendorf tear test is satisfactory in the range of 175 to 225 grams per 16 sheets in the machine direction and 230 to 280 grams per 16 sheets in the cross direction.

MOISTURE CONTENT

The range of moisture content is also critical in regard to caustic absorbency.

The rate and uniformity of caustic absorption by the sheet if overdried to a value below 5% water are very erratic and result in a final product containing many unreacted fibers.

The optimum range of moisture content has been found to be from 5 to 7%.

SOLUTION FIBER TEST†

The quality of the sheet uniformity and the caustic absorbency properties of the pulp fiber are measured by a solution fiber evaluation test made upon the final cellulose derivative.

The addition of known amounts of pulp fiber to a water solution of a cellulose derivative indicates that if there is as much as 0.50% fiber in the sheet not impregnated with caustic, an unsatisfactory product is obtained.

SUMMARY

In the viscose process, it is obvious that a special pulp sheet having very definite physical properties is needed. In the order of their importance, these are: uniform sheet formation, basis weight, and caliper—within certain narrow ranges to give the desired densities and porosity—as related to density.

† A 1% water solution is centrifuged in a centrifuge tube (oil, ASTM, 100 ml., long form) to measure insoluble fraction.

Received Dec. 18, 1953. Presented at the 39th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 15–18, 1954.

ASSOCIATION NEWS AND EVENTS

Fifth Testing Conference

The Fifth Testing Conference will be held at the Hotel Biltmore, Dayton, Ohio, on Oct. 6, 7, and 8, 1954. Wednesday, October 6, will be devoted to committee meetings of all committees in the Testing Division. At this time, various methods under the jurisdiction of these committees will be discussed and all members of TAPPI, whether committee members or not, are invited to attend and enter into the discussion.

At 9:00 a.m. and 2:00 p.m. Thursday and again at 9:00 a.m. Friday, sessions will be held in which new testing methods and techniques will be discussed. Papers to be presented during these sessions are as follows:

"Testing Water for Radioactivity," by Frank Slaby, Riegel Paper Co., Milford, N. J.
"New Recording Fluorescence Size Tester," by J. A. Van den Akker, W. A. Wink, and K. W. Hardacker, Institute of Paper Chemistry, Appleton, Wis.
"The Application of Infrared and Ultraviolet Spectroscopy to Paper Problems," by A. S. O'Brien, Eastman Kodak Co., Rochester, N. Y.
"Cross-Sectioning of Coated Papers," by Robert P. Stoll, Eastman Kodak Co., Rochester, N. Y.
"Microscopy of Ink-Paper Relationships," by John J. Kelsh, Interchemical Corp., New York, N. Y.
"Investigation on the Breaking of Bonds in Paper During Tensile Testing," by L. Nordman, Research Institute of the Finnish Pulp and Paper Industries, Helsinki, Finland
"New Developments in Porosity and Smoothness Testing," by N. Emmons and W. I. Wilt, Sheffield Corp., Dayton, Ohio
"New Techniques in the Optical Testing of Paper," by Richard S. Hunter, Hunter Associates Laboratory, Falls Church, Va.
"A Survey of Recently Proposed Methods for Evaluating the Printability of Paper and Paperboard," by George R. Sears, Institute of Paper Chemistry, Appleton, Wis.
"TAPPI's Proposed Standard Reference Pulp Program," by Frank E. Caskey, Crown Zellerbach Corp.

In addition to the above-listed papers, it is expected that papers will be presented on "The NBS Stiffness Tester," "New Developments in Pulp Testing," and "The Use of Statistics for Analysis of Testing Results."

On Friday afternoon, October 8, arrangements have been made for members of the Conference to visit the printing plants of McCall Corp. and the National Cash Register Co.

On Thursday evening, the Ohio Section of TAPPI is holding its regular monthly meeting at the Hotel Biltmore and all members attending the Testing Conference are invited to attend. A prominent speaker will be obtained for this occasion.

Throughout the Conference, various instrument manufacturers will exhibit new testing equipment which has been developed in the last few years.

Local Sections

Pacific: Sept. 27–28, 1954, Seattle, Wash., and Sept. 30–Oct. 1, 1954, Portland, Ore. Eighth Annual Seminar. "The Structure of Paper," by H. F. Rance; Sept. 29, 1954, Portland, Ore., "Engineering"; Nov. 9, 1954, Bellingham, Wash., "Instrumentation"; Jan. 11, 1955, Longview, Wash., "What's New in Pulping?"; March 4, 1955, Everett, Wash., Annual Shibley Award Contest; May 18–21, 1955, Victoria, B. C., Annual Meeting. Jointly held with CPPA and Superintendents Association.

Kalamazoo Valley: Sept. 30, 1954, Hotel Harris, Kalamazoo, Mich., "Theoretical Approach to the Problems of Multicylinder Drying," by A. H. Nisson, Professor of Textile Chemistry, The University, Leeds, England; Nov. 4, 1954, "What Holds Paper Together?" by H. O. Ware, Hercules Powder Co., Wilmington, Del.

Southeastern: Oct. 1–2, 1954, Valdosta Country Club, Valdosta, Ga., Borje Steenberg, Forest Products Research Laboratory, Stockholm, Sweden; Nov. 12–13, 1954, King & Prince Hotel, St. Simons Island, Ga.; Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis.; Jan. 14–15, 1955, Francis Marion Hotel, Charleston, S. C.; March 18–19, 1955, George Washington Hotel, Jacksonville, Fla.; May 13–14, 1955, De Soto Hotel, Savannah, Ga.

Chicago: Sept. 20, 1954, Chicago Bar Association Quarters, Chicago, Ill., "Folding Cartons," by Leonard Scheck, General Manager, Cartons Dept., Lake Shore Plant, Container Corp. of America, Chicago, Ill.

Lake States: Sept. 23, 1954, Appleton, Wis., Borje Steenberg, Forest Products Research Laboratory, Stockholm, Sweden.

Delaware Valley: Sept. 16, 1954, Visit to Scott Paper Mill, Chester, Pa., followed by dinner and meeting at Chester Country Club. "A Theoretical Approach to the Problems of Multicylinder Drying," by A. H. Nisson, The University, Leeds, England.

New England: Oct. 8–9, 1954, Berkshire Inn, Great Barrington, Mass., joint meeting with Superintendents Association; Dec. 10, 1954, Roger Smith Hotel, Holyoke, Mass., "Microscopy with Regard to Stock Preparation"; March 25, 1955, Hotel Statler, Hartford, Conn.

Ohio: Sept. 16, 1954, Manchester Hotel, Middletown, Ohio, W. Brecht, Technical University, Darmstadt, Germany; Oct. 7, 1954, Biltmore Hotel, Dayton, Ohio (TAPPI Testing Conference).

Empire State: June 9–11, 1955, Whiteface Inn, Lake Placid, N. Y.

Empire State (Metropolitan District): Sept. 14, 1954; Fraunces Tavern, New York, N. Y., "Recent Developments in Coatings," by W. L. Hardy, Foster D. Snell, Inc., New York, N. Y.; Oct. 19, 1954, Nov. 9, 1954, Dec. 14, 1954, Jan. 11, 1955, March 8, 1955, April 12, 1955, May 10, 1955.

Empire State (Western District): Oct. 6, 1954, Robert Gair Co., Fort Niagara Plant; Nov. 3, 1954, joint meeting with Niagara Branch, CPPA Technical Section. Panel on "Instrumentation"; Dec. 1, 1954, Regional Executive Meeting, R. G. Macdonald, Secretary-Treasurer, TAPPI, Speaker; Feb. 2, 1955, visit to J. W. Clement Plant in Buffalo, N. Y.; March 8, 1955, joint meeting in Canada with CPPA Niagara Branch; April 6, 1955, Suppliers Night Discussion on "Availability of Raw Materials"; May 4, 1955, annual meeting and ladies night, Lockport, N. Y.

Lake States

The TAPPI Lake States Section has scheduled the following meetings for 1954–55:

Sept. 23, 1954: Conway Hotel, Appleton, Wis., "The Principles of Screening System Design," by Borje Steenberg, Forest Products Research Laboratory, Stockholm, Sweden.

Nov. 9, 1954: Riverside Country Club, Marinette, Wis., afternoon visits to the plants of the Marinette Paper Co. and The Badger Paper Mills. Demonstration program sponsored by Ansul Chemical Co.

Plant Visits on November 19

The following companies have extended an open house invitation to the delegates to the Corrugated Containers Conference to visit their plants on November 19:

Container Division, International Paper Co., Georgetown, S. C.
National Container Corp., Jacksonville, Fla.
Gaylord Container Corp., Atlanta, Ga.

Room reservations should be made directly with the General Oglethorpe Hotel, Wilmington Island, Savannah, Ga.

Sixth Coating Conference

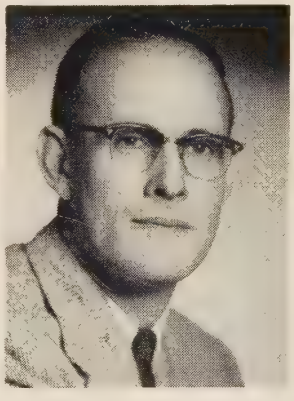
The dates for the Sixth TAPPI Coating Conference to be held in Cleveland, Ohio, have been set for May, 1955. The conference, which was previously announced for the Fall of 1955, will be held in May to avoid conflicts that would have arisen in connection with the Fall dates.

"Pulp and Paper Manufacture"

The publishers of the four volumes of "Pulp and Paper Manufacture" have indicated that Volume 4 which is now in galley-proof state will be ready for distribution in the late Fall of this year. At present it is not possible to set a price but individuals and companies that care to do so may place orders with the Book Department of the Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y., and thereby anticipate the earliest possible delivery. As is generally known these volumes are very carefully edited and proof-read and consequently they are not bound and shipped until they have been approved in every detail by the publisher.

Acid Pulping Committee

Norman S. Lea, technical control manager of the pulp mill, West Coast Division of the Scott Paper Co., Everett, Wash., has been appointed chairman of the TAPPI Acid Pulping Committee, succeeding E. H. Woodruff of Rayonier, Inc., Port Angeles, Wash.



N. S. Lea, Scott Paper Co.; Chairman, Acid Pulping Committee

Associated with Mr. Lea will be K. G. Booth, Crown Zellerbach Corp., E. O. Ericsson, Puget Sound Pulp & Timber Co. P. J. Frost, Oregon Pulp & Paper Co., F. J. Weleber, Publishers Paper Co., and E. H. Woodruff. G. H. McGregor of the Minnesota & Ontario Paper Co. will continue as chairman of the Lake States Subcommittee and F. J. McCourt, Jr., will continue as chairman of the Eastern Subcommittee.

Austrian Meeting

The Institute of Pulp and Paper Technology, Graz, Austria, will conduct a scientific meeting at Graz on Oct. 15–16, 1954. The following lectures will be given:

1. "Basis, Principles and Developments of the Rheinau Process," by E. Hagglund, Svenska Traforskningsuistitutet, Stockholm, Sweden.
2. "The Judgment of Wood Saccharification by Standards of Modern Chemical Industry," by K. Schoenemann, Technical University, Darmstadt, Germany.
3. "Lignin and Lignin Derivatives," by Fritz Brauns, Institute of Paper Chemistry, Appleton, Wis.
4. "Application and Use of Lignin-Resins in Plastics," by A Apel, Chemische Holzverewertung G.m.b.H., Mannheim Rheinau, Germany.
5. "The Chemical Structure of Hemicellulose in Straw," by A. Roudier, National Chemical Services Central Laboratory, Paris, France.
6. "Importance and Possibilities of Wood Saccharification," by K. Adanuk, Technical University, Graz, Austria.

Ninth Engineering Conference

The Ninth TAPPI Engineering Conference will be held at the Benjamin Franklin Hotel, Philadelphia, Pa., on Oct. 18–21, 1954. The program of the meeting was published in the August issue of *Tappi*.

Local Committee

Much work is required of the members of a local arrangements committee prior to an important conference of this type. The members of the committee are as follows:

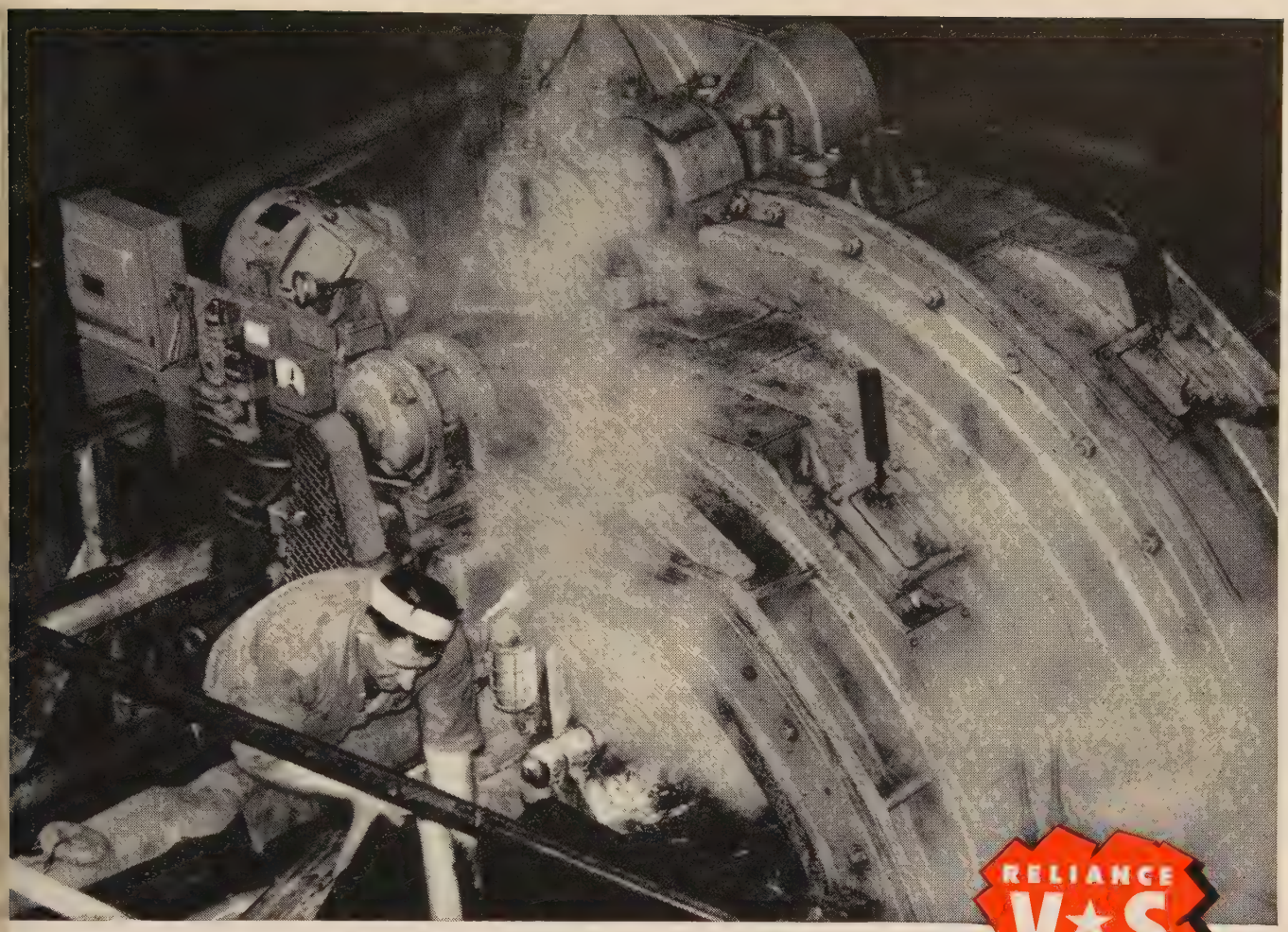
Chairman—J. C. Harper, Downingtown Mfg. Co., Downingtown, Pa.
Co-chairman—Edw. J. Albert, Thwing-Albert Instrument Co., Philadelphia, Pa.
Secretary-Treasurer—Henry S. Dimmick, SKF Industries, Inc., Philadelphia, Pa. (*Note:* C. H. Rice, Westinghouse Electric Corp., preceded Mr. Dimmick as Secretary-Treasurer but was transferred from Philadelphia to Pittsburgh by his company.)
Chairman, Hotel Arrangements Committee—John R. Curtis, Scott Paper Co., Chester, Pa.
Chairman, Hospitality Committee—William Kurlish, General Electric Co., Philadelphia, Pa.
Chairman, Mill Visits Committee—Robert C. Ridings, Container Corp. of America, Manayunk, Pa.
Chairman, Publicity Committee—Emerson N. Glauner, Downingtown Mfg. Co., Downingtown, Pa.
Chairman, Delaware Valley Section—Emil Padavic, Container Corp. of America, Manayunk, Pa.
Chairman, Sponsors Committee—W. D. Harrison, Riegel Paper Corp., Milford, N. J.
Chairman, Registration Committee—W. H. Taylor, Allis-Chalmers Mfg. Co., Philadelphia, Pa.
General Committeemen—Carl Ackerman, Union Mills Paper Mfg. Co., New Hope, Pa; Charles E. Hill, Pusey & Jones Corp., Wilmington, Del.; Frank J. Lovegren, P. H. Glatfelter Co., Spring Grove, Pa.; John D. Lyall, Armstrong Cork Co., Lancaster, Pa.; Joseph P. McTommoney, Moore & White Co., Philadelphia, Pa.; Thomas F. Sheerin, Moore & White Co., Philadelphia, Pa.

Conference Speakers

The speaker at the Engineering Division luncheon will be H. W. Prentis, Jr., chairman of the board, Armstrong Cork Co., Lancaster, Pa., and former president of the National Association of Manufacturers. Recently, Mr. Prentis has been named by former President Hoover to head the task force to study all phases of overseas economic operations by Government agencies. Among other things, the group will survey the work of the Foreign Operations Administration, apart from the military phases; check on the Point 4 aid to underdeveloped countries; study the general problem of staffing American Embassies abroad with specialists from the Commerce, Agriculture, and Labor Departments; look into the similarity of activities by the Foreign Operations Administration, the State Department, and the Commerce Department in trade promotion and the investment of American capital abroad; and study the economic reporting activities of the State Department which are carried out for other Government agencies.

The Sponsor's Dinner speaker will be James Q. du Pont, a great great grandson of the founder of E. I. du Pont de Nemours & Co., Wilmington, Del.

In a talk entitled "We're Working While Rome Burns," Mr. du Pont will make several major observations and draw some basic conclusions on the American business and industrial "picture" as he sees it today. "These conclusions," he



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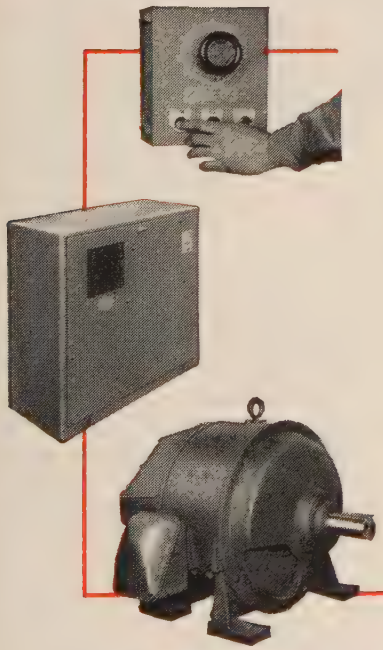

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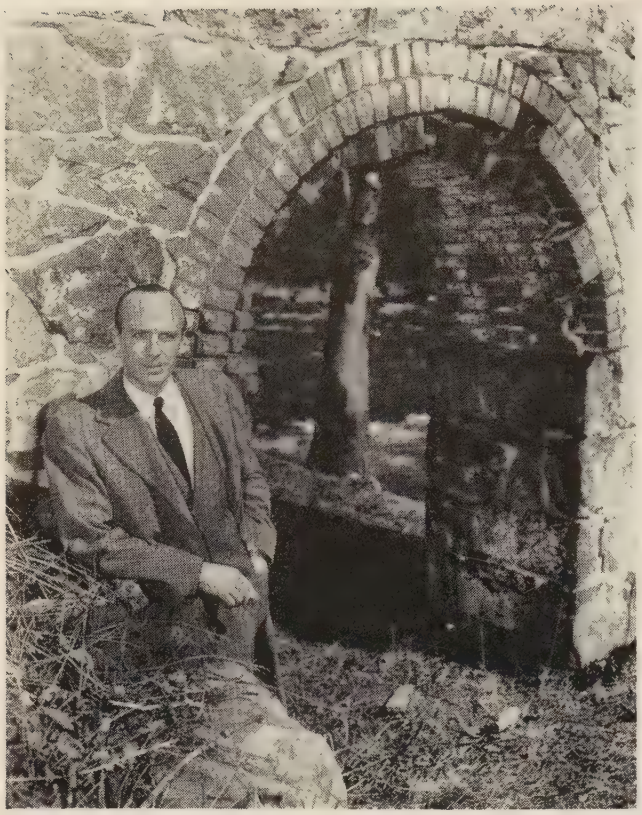

James Q. du Pont standing by an arch of one of the original powder mills on the site of the beginning of E. I. du Pont de Nemours & Co., near Wilmington, Del.

says, "are based on my almost endless travels to practically every section of the U.S.A. during the last five years."

With a mixture of confidence and fear in his words, du Pont says, "I've been 'feeling the business pulse' of our great, good nation steadily now since 1948, and I want to tell people about it, quickly!"

Mr. du Pont is administrative assistant, Public Relations Dept. of the du Pont Co. with headquarters in Wilmington. A trained engineer, with a degree in electrical engineering from the Massachusetts Institute of Technology, he comes to this meeting with a broad background of engineering experience and wide recognition as a public speaker.

After his graduation from M.I.T. in 1926, he went to work as superintendent of bus maintenance for the Johnstown Traction Co. About 1932, he went into business for himself, operating a commercial and industrial photographic service in Johnstown. When he joined the du Pont Co. in 1940, his first job was with a construction crew then building a new cellophane plant at Clinton, Iowa. He later served as project engineer in the cellophane operations there until 1942 when the Remington Arms Co., a subsidiary of du Pont, asked for his services at Kings Mills, Ohio.

In 1943, he returned to the du Pont Co. for instrument work on the atomic energy project at the University of Chicago in connection with the program the company undertook at the request of the Government. From then until the end of the war, he was identified with the work at Oak Ridge, Tenn., and the Hanford Works in Washington.

When the du Pont Co.'s major part in that atomic energy program ended in 1946, Mr. du Pont returned to the company's Engineering Dept. in Wilmington. He joined the Extension Division of the Public Relations Dept. in 1948 and became administrative assistant of that department in July of 1952. Since 1948, Mr. du Pont has rapidly gained national recognition as a public speaker.

Technical Papers

The following papers will be presented. Brief abstracts of the papers that are now ready are included:

Paper Mill Rehabilitation Involving Rebuilding an Old Paper Machine Versus a New Machine, by John A. McPherson, Mosinee Paper Mills, Mosinee, Wis., and Harold G. Ingraham, Chas. T. Main, Inc., Boston, Mass.

This presentation concerns itself with the manner in which Mosinee Paper Mills Co. went about rebuilding a paper machine. This was no ordinary rebuild job, since it required complete removal of the entire machine and restoring it as a modern high-speed production unit. The first part of this discussion describes the reasoning behind certain basic decisions and what prompted management to authorize rebuilding a machine versus installing a new one. "To buy a new machine or rebuild the old—that is the question."

The sales department first made a market analysis to provide estimates of the volume of product that can be marketed. An engineering survey, analysis, estimates of cost, and report on the complete project enabled management to evaluate the economics of added productive capacity. The report indicated that, if a new machine were installed, the pulp requirements to sustain it and the existing machines would be greater by 100 tons per day than the pulp mill could produce. To develop additional pulp capacity would require a large capital outlay for digesters, chemical recovery, power and steam, and stock preparation equipment.

On the other hand, a new machine would have many advantages over a rebuilt one. The authors describe and compare the advantages and disadvantages of one over the other and how these features influenced the final decision to rebuild the existing machine.

In the second part of this presentation some interesting phases of job organization and job management are described and how certain difficult construction problems were overcome before and during the actual shutdown for rebuilding. Details of advance planning are given, also the logistics of handling machine parts and construction material during a highly concentrated period of construction activity. Pictures will be shown of the machine before, during, and after rebuilding.

Methods for Preparing and Presenting Requests for Project Approval, by E. K. Murphy, Rayonier, Inc., New York, N.Y.

In seeking approval for capital projects, the chief engineer must invariably prepare his approach along economic lines, for there must always be a good relationship between expenditures and earnings if the company is to prosper. It is from this desired relationship that the capital budget was conceived and it follows that each and every project should pass the tests imposed by this budget.

Form of submittal can be very important. The management committee passing on expenditures will include individuals interested only in conclusions, costs, and earnings; it will often include some who will be interested in studying the logic back of these conclusions. To anticipate such diverse reception, the report-plus-digest approach is recommended.

The Engineering Report, usually prepared by the engineering staff, will include a statement of the problem, available and recommended solutions, engineering recommendations, cost estimates, and an economic picture.

The Digest, prepared by the chief engineer, should briefly review the problem, the recommended solution, any technical risks involved, estimated costs and savings, and the economic justification for the project. The latter must answer the all-important question: "Will it pay?"

Management will appreciate a Digest which includes costs and savings estimates in such form that several economic yardsticks can easily be applied to answer this question return on investment. Such yardsticks may include rule-of-thumb methods, such as the number of years required for savings to

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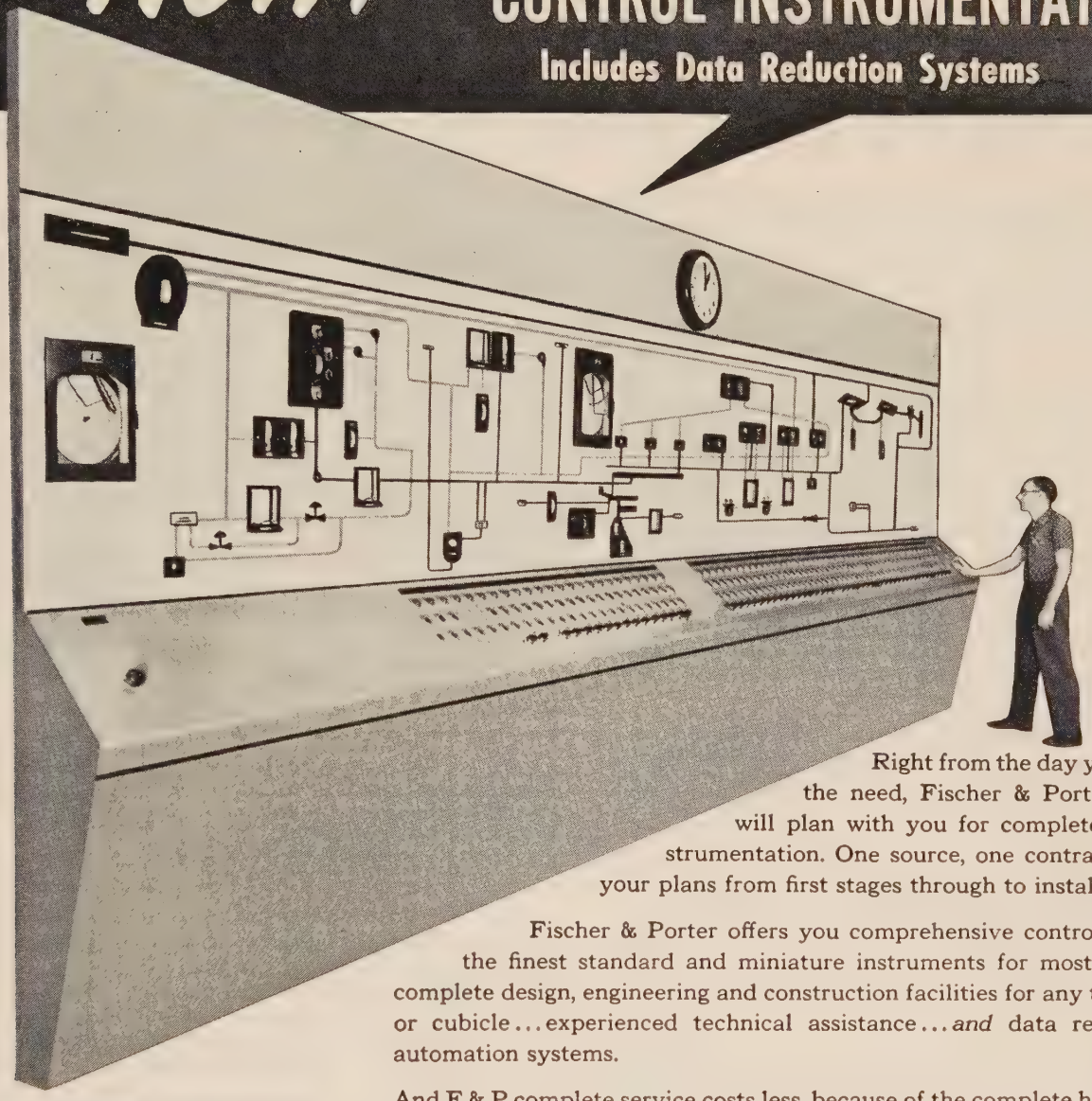

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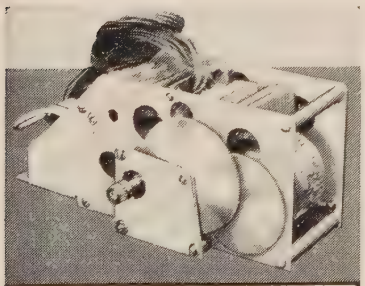

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repay outley, or more exact methods, such as computation of rate of return on investment in proportion to the length of time each increment of capital is assigned to that project.

Presentation along the lines indicated tends to insure that the project will obtain its full due consideration when being compared to other pending projects which may also be competing for a place in the capital budget.

Simultaneous Burning of Bark and Coal at Champion, by Harold Hansen, Champion Paper & Fibre Co., Canton, N. C., and L. P. Copian, Riley Stoker Co., Worcester, Mass.

Faced with the requirement for additional steam capacity, the Champion Paper and Fibre Co. of Canton, N. C., decided that a new steam generating unit firing bark and coal was needed.

Studies of existing methods for efficient utilization of bark were made and based on these studies and the company's extensive experience with bark burning. It was decided to install a spreader stoker-fired boiler of the two-drum, single-pass, baffleless design. The unit has a water-cooled furnace, superheater, heat recovery equipment, and dust collector. Nominal rating is 200,000 lb. steam per hour at 425 p.s.i.g. and 750° F.

The installation is designed to burn unhogged bark and coal in combination or alone. The bark is distributed in the furnace by pneumatic distributors, and coal is distributed by mechanical feeders. The spreader stoker traveling grate is of the rear ash discharge type.

There is no bark storage, since the unhogged bark is fired directly as received from the drum barkers. Coal is used to supplement the bark and also to even out the steam flow.

The control system is arranged so that the unit fires all the bark it receives and at the same time maintains any set minimum loading by burning coal at the required rate. The plant steam pressure is maintained by one of the other boilers in the plant.

The excellent performance of the unit is evidenced by the data collected over a typical, 5-day, 24-hour period. Bark evaporation rates (pounds steam per pound bark) are in the order of 3.5. Grate refuse combustible runs in the order of 1.5%.

Individually, there are certain practices in the field of bark burning which are of common usage. The major innovation of this installation is the inclusion of several of the more desirable of these features into the design of a modern bark burning spreader stoker installation.

Outdoor Power Stations as Applied to the Pulp and Paper Industry, by J. R. Chapman, Stone & Webster Engineering Corp., Boston, Mass.

The subject of outdoor power stations has received much publicity and aroused considerable controversy with regard to both its economics and operational utility in the field of central power stations. It is only natural that the industrial power plant designer should carefully consider the pros and cons of outdoor station design both for new plants and additions to existing ones. A significant factor exists in the fact that a central station generates power for sale as kilowatts whereas the prime commodity of a manufacturing plant is something far different and in the case of the pulp and paper industry is a highly specialized and extremely varied type of product. The large amount of steam and power used by the pulp and paper industry requires careful coordination of the availability of these utilities with production demands and such factors as availability of load and maintenance of equipment must be subordinate to the manufacture of the finished product.

It is recognized that economies of construction may be realized by reducing the type and extent of building enclosure and the paper outlines in a general way the advantages and disadvantages of power plant designs ranging from completely enclosed stations to those built "all outdoors." It also considers savings in first cost without overlooking the intangible factors of operator comfort, maintenance, and availability of steam and power generating equipment.

Identification of Surface Conditions in Digesters, by L. A. de la Grange, West Virginia Pulp & Paper Co., New York, N. Y.

Review of Digester Corrosion Causes, by W. B. Parker, Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.

Comparative Analysis of Digester Corrosion Measurements, by H. O. Teeple, International Nickel Co., New York, N. Y., and N. Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y.

Application and Design Characteristics of A.C. Motor Control, by R. W. Foster, Champion Paper & Fibre Co., Canton, N. C.

The a.c. motor control is the brains behind the motor, directing the proper application of motive power to the driven machinery. Control performs the basic function of starting and stopping the motor, in special cases, of adjusting its speed. In addition, a good controller protects the motors and driven machinery against damage due to overloads. It protects the motor branch circuit against damage due to short circuits and it protects the operator against injury due to faulty operation and accidental contact with live parts. Constant speed squirrel-cage motors, which are the largest group of industrial motors, are generally equipped with full voltage starters. Pushbutton operated magnetic starters provide undervoltage protection. Inherent overload protection is generally obtained by use of solder film or bimetal thermal overload relays which simulate the heating characteristics of the motor. For short-circuit protection, fuses or molded case air circuit breakers are generally employed. Reduced voltage starters are used in cases where technological reasons demand a reduction in starting torque or power system limitations demand a reduction in starting current. When speed adjustment is required, wound-rotor motors are used with control of secondary resistance. When a multiplicity of motors is installed in a plant, starters may be grouped in a motor control center which is a coordinated assembly of combination starters, resulting in greater convenience to maintenance, better coordination, and possible saving in installation expense. For large motors, distribution system economies make high voltage attractive. Controllers should have adequate interrupting rating. Special attention must be given to the design of enclosures and control circuits of high-voltage starters to safeguard operations.

The Selection of Chipper Drives, by M. J. Osborne, Bowaters Southern Paper Corp., Calhoun, Tenn.

The Chipper Drive Subcommittee has studied data from some 50 chipper installations to determine power requirements for chipping wood of various species.

There is little uniformity in chipping, chipper design, or motor drives. Chippers with 4 to 12 knives are driven from 200 to 600 r.p.m. to produce chips $^1/_2$ to 1 in. long from woods with a shear stress range of 690 to 2100 p.s.i. The power requirements vary from 4.1 to 10.6 hp.-hours per cord.

Power requirements vary with the shear stress of the wood. A table has been made to show maximum, minimum, and average power requirements of the various species of wood.

The most economical buy for synchronous motors is 250% pull-out torque and 0.8 power factor instead of unity power factor and 300 or 350% pull-out torque.

If a blower is used on the chipper to convey chips this incremental power should be added to the power for chipping to select the proper motor size.

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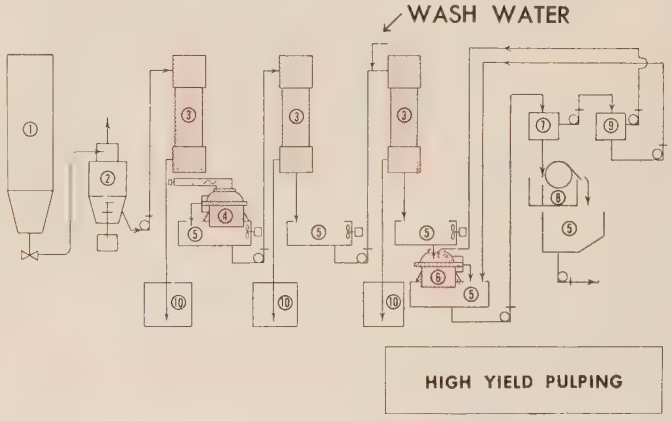

IN THE J-C HIGH YIELD PULPING SYSTEM—

- *pressure washers replace diffusers or vacuum washers . . . can operate at higher temperature*
- *Roto-Pulper defibers chips at 40% consistency . . . cuts power costs per ton*
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THE J-C HIGH YIELD PULPING SYSTEM—

- *gets pulp cleaner with less dilution—requiring less evaporator capacity*
- *allows adequate time for diffusion between stages*
- *gives complete freedom from foaming or soaping problems connected with conventional systems*
- *requires smaller chests, pumping and piping . . . cuts equipment and installation costs.*

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Equations, charts, and nomographs have been assembled or developed by this committee to assist engineers in the selection of synchronous or induction motor drives.

Two methods for determining chipper motor size have been developed by this committee. Both systems have been assembled into TAPPI Data Sheet form. They will be made into data sheets if the Electrical Engineering Committee so approves.

The Scope of Industrial Engineering in the Pulp and Paper and Allied Industries, by J. M. MacBrayne, Union Bag & Paper Corp., Savannah, Ga.

The increasing magnitude and complexity of modern industrial plants during the past 25 years have resulted in the development of Industrial Engineering. While there has been considerable application of Industrial Engineering in the conversion phases of the pulp and paper industry, recently there has been an increasing use of the same techniques in the pulp and paper mills themselves. The Industrial Engineer, trained both in engineering and fundamental business management techniques, applies his background and experience to the following areas of study:

A. *Methods Improvement.* Develops the best way of doing work through flow process charts, time study, motion study, and micromotion study.

B. *Materials Handling.* This is particularly important in the pulp and paper industry. A surprisingly large portion of the total product cost and area occupied by many mills is due to the handling of materials and in many cases little has been done to improve the situation. This involves determination of the best method and the selection of the proper equipment for the job.

C. *Plant Layout.* The layout of a plant can assure maximum efficiency through proper flow of materials with minimum cost and maximum utilization of personnel. The Industrial Engineer helps achieve this by complete analysis of the problems involved, presenting his findings to management in the form of scale layouts for discussion and approval.

D. *A Fair Day's Work.* As competition grows and labor costs mount, it becomes increasingly more important that we attain maximum utilization of labor. Through detailed study of operations, the Industrial Engineer determines a fair day's work, developing a well-balanced and effective labor force.

E. *A Fair Day's Pay.* Studying factors that go to make up every job, considering the skills, effort, responsibility, and conditions required, the Industrial Engineer determines the relative value of each job allowing management to better determine proper wage rates.

F. *General.* Because of his broad training the Industrial Engineer is called upon to handle many problems which overlap other engineering fields, particularly when the problem involves economic analysis in one of the fields in which he is particularly trained.

Wood Room Refuse Fuel Handling, by George H. McGregor, Minnesota & Ontario Paper Co., International Falls, Minn.

Description of the plant installed by the Minnesota & Ontario Paper Co. for handling and burning of wood room refuse (bark, sawdust, solid wood pieces including slivers and chip screen rejects). Some of the initial problems are described as well as the method of handling fly ash. Recent figures, including Winter and Summer operation, have indicated that the furnace will handle an average of 96 tons per day of wood refuse to produce 30,000 lb. of steam per hour at 450 lb. operating pressure.

The Application of Industrial Trucks in the Pulp and Paper Industry, by Lee Cirello, Towmotor Corp., Cleveland, Ohio.

An industrial power truck is a mobile power-driven piece of equipment operated within the confines of an industrial plant for the systematic mass handling of raw, in-process, and finished materials.

There are many basic types of industrial trucks, each of which could be the subject of a paper. In this presentation, however, the spotlight is focused on the fork lift truck and the many attachments which contribute to its versatility.

Because it is primarily an indoor truck and is required to operate within the confines of factory aisles, dock areas, minimum warehouse aisles, boxcars and trailers, the lift truck must be compact, agile, and light in weight. Basic design features discussed include general arrangement of truck components, power plants, transmissions, and lifting mechanism.

Lift trucks today not only can lift and travel with a load but can rotate, upend, sideshift, push, pull, grab, scoop, and swing all types of loads with equal ease. A lift truck can readily be converted to perform the functions of a crane truck, a ram truck, an end-loader, or a tractor. Basic attachments incorporating these motions are described and their applications touched upon.

One of the outstanding uses of lift trucks in the pulp and paper industry is the handling of paper rolls. The current trend in the production of larger and heavier rolls is creating handling and shipping problems which are discussed in the light of available lift truck equipment, current railway facilities, and proposed new freight rates.

The lift truck supplemented by the many multipurpose accessories has become a permanent factor in all phases of management planning because of its contribution in effecting large savings in materials handling labor costs, faster handling reflected in increased productivity, optimum utilization of storage space by providing means for high stacking, reduction in material damage, and safer material handling as reflected in fewer injuries and higher morale among labor personnel.

Noise Control in Paper Mills and Converting Plants, by R. H. Caston and M. N. Davis, Kimberly-Clark Corp., Neenah, Wis.

Many a mill manager, superintendent, and plant engineer, as he approaches his daily work, listens for the familiar sounds that tell him that "all is well." The distant thunder of the drum barker, the chatter of the exhausts of vacuum pump and air compressors, the whine of suction rolls on high-speed paper machines are music to his ears.

We do not wish to spoil this man's music, but we suggest that if it were softer, he would be as happy and:

1. He and other supervisors would more frequently visit the noisy areas.
2. His machines would be better maintained, because tell-tale noises could be heard.
3. The noisy areas would be safer, as well as more pleasant, places in which to work. Warning signals need be less raucous.
4. Fewer of the older employees would need hearing aids. Potential liability for workman's compensation because of hearing damage would be reduced.
5. Communication between employees would be easier, more rapid, and less subject to costly error.

We have made surveys of the noise level in the mills of the Kimerly-Clark Corp. and its subsidiaries and affiliates. The pieces of equipment sometimes found to be especially noisy were:

Slasher saws	Large motors
Drum barkers	Vacuum pumps
Chippers	Suction rolls
Pulp screens	High pressure air nozzles
Refiners	Pneumatic equipment
Hammermills	Some converting equipment

Reduction of the noise from each piece of noisy equipment requires separate consideration of whether:

1. Operators must be continuously or only intermittently exposed to the noise. Seldom-heard noise does little harm.

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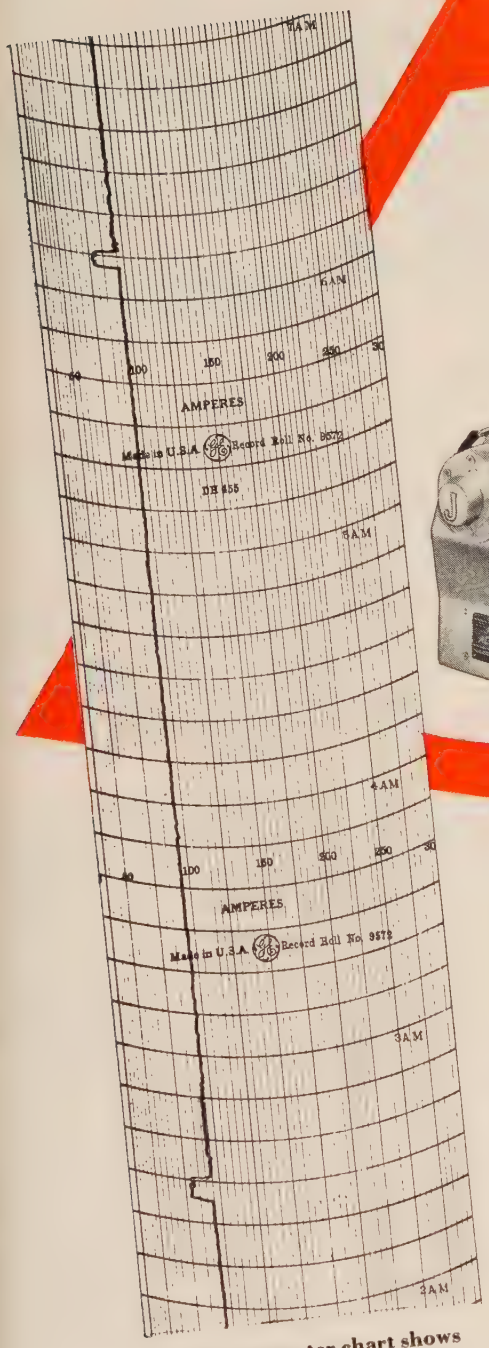
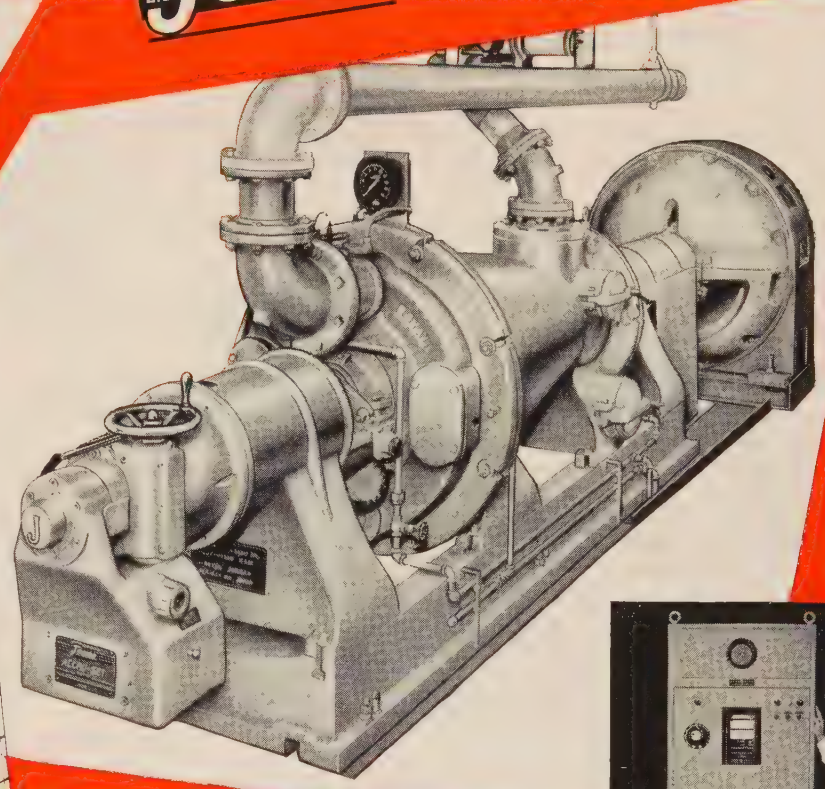
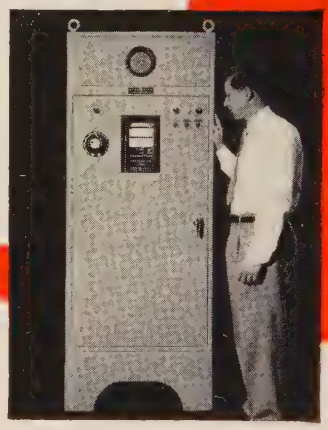


This watt-meter chart shows uniformity of Jordan performance with Accru-Set Control.





Jones Royal Jordan (top) in Western Electric's Hawthorne Works, Chicago, has been operating under Accru-Set Control for a year. Inset shows typical control panel.

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2. Redesign of the equipment can reduce the noise level sufficiently.
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Vibration Measurement and Roll Balancing with the Vibration, by James T. Roberts, International Research & Development Corp., Columbus, Ohio.

Vibration, due to unbalance, costs you hundreds of dollars every day. Industrial studies by a prominent research organization and large primary metals manufacturer show that 50% of motor failure is due to bearing failure and that 83% of bearing failure is due to vibration. Many industries have found that by using portable vibration analyzers to locate and correct vibration they have eliminated unscheduled production shutdowns due to mechanical failure in the equipment. Roll balancing is now possible in the completed assembly, the finishing machine, or a simple and inexpensive turning arrangement. Speed and size of the equipment to be balanced are no longer a problem. The largest lathe manufacturer in the country feels that the vibration analyzer solves 90% of their trouble by quickly and simply pinpointing the predominate cause of the "shake." They then eliminate the vibration by balancing with the same instrument, in assembly, the rotating part causing the trouble or replacing the indicated defective belt or bearing. A sound preventative maintenance program based upon acceptable standards of vibration determined and maintained by this portable electronic equipment enables the quick correction of the vibration before serious trouble develops. Failures during production have been eliminated, maintenance costs decreased, higher productive machine speeds reached, increased machine life, and many other benefits result from the use of vibration analyzers.

Test Data on Drier Bearing Friction, by L. H. Moore, The Black-Clawson Co., Hamilton, Ohio.

Instrumentation Maintenance in Paper Mills, by Edward J. Kehoe, Marinette Paper Co., Marinette, Wis.

Instrumentation is comprised of three things: instruments, people, and facilities for maintaining instruments. All three are essential if we are to reap the many benefits which may be realized through the use of instruments.

Manufacturers have expended much effort to make their instruments marvels of precision and dependability. The paper industry lags far behind in the application and use of instruments. We have had good instruments available for years but they were of little benefit to us because we overlooked the people or facilities or both.

Lack of people familiar with instruments is probably the biggest obstacle in the way of successful instrumentation in paper mills in general. Few plants know how to obtain or train the needed man power. There seem to be two schools of thought regarding selection of men. One faction believes that many men will be good instrument men with proper supervision and training. The other faction believes that very few men will be successful in instrumentation and their selection must be very carefully made. Who is right depends largely upon the size and type of plant.

Careful consideration must also be given to where these men are going to fit in the over-all plant organization. An instrument department usually has much to offer departments such as engineering and technical. It is also true that some departments can contribute materially to the success of the instrument department.

Facilities for maintenance are sadly lacking in most paper mills. Productivity in such small departments as instrument maintenance can easily be strangled by regulations and systems so necessary in larger maintenance departments. We cannot measure the effectiveness of such a highly skilled effort by the same standards we use in other more mechanical activities. Shops must be located and equipped especially for instrument maintenance without interference from other services. Records and methods must be more thorough.

The entire instrumentation program should be reviewed from time to time to make certain maximum benefits are being derived and to chart our course in this ever expanding field. Many of the problems which have plagued papermakers for years can be solved if instrumentation is supported and given its proper place.

Coordination of Instrumentation Engineering with Mill Operations, by J. R. Upson, Union Bag & Paper Corp., Savannah, Ga.

The Application of a Suction Hot Press to the Drier Section of a Paper Machine, by J. C. Harper, Downingtown Mfg. Co., Downingtown Pa.

The addition of heat to elevate the temperature of a sheet of paper during formation has long been considered an aid to water removal. Increased temperature has the apparent effect of increasing the freeness of stock, thereby permitting more rapid and complete drainage.

Established experimental data show that increasing the temperature of water decreases its viscosity and surface tension. Such being the case, it is a logical conclusion that if a sheet is first heated to a suitable temperature and then subjected to pressure, additional moisture can be expressed from the sheet. This additional moisture would not be released under similar safe press loading at ordinary sheet temperatures.

In accordance with this theory a heavy duty suction press was installed in the drier section of a fourdrinier kraft machine. In order to install the press, the third plain press and ten driers from the first section were removed. Seven driers were reinstalled directly after the second suction press and this group of driers serve as preheaters for the suction hot press.

The location of the press was decided after taking temperature readings in the original drier section to determine the point at which the highest possible temperature, without appreciable evaporation, could be reached. This temperature was determined to be approximately 160°F. The preheater driers were close hooded to reduce natural air circulation as much as possible.

Moisture tests were taken before and after the hot press was installed. Press loadings have been run up to 475 lb. per inch without sheet distortion. Burst, stiffness, and moisture tests remain comparable on most basis weights. Caliper decreased on all grades. Lower steam pressures indicate reduced steam consumption.

Over-all gain in performance from available tests shows increased drying capacity of 12 to 15%, caliper reduced 7 to 9% with increased sheet density, and steam savings 8 to 14% depending on weight.

Calender Cooling on the Modern Paper Machines, by L. G. Janett, J. O. Ross Engineering Corp., Chicago, Ill.

The difficulties in building good reels at the end of paper machines have been gradually increasing along with increasing machine speeds. Adequate spot cooling of calender rolls has been under considerable examination during the last few years in order to improve reel qualities and help the back tenders in performing their work.

On newsprint machines in particular the need for better cooling at higher speeds has resulted in general redesigning and improving of calender cooling methods that have been used for many years. From the experience on these machines

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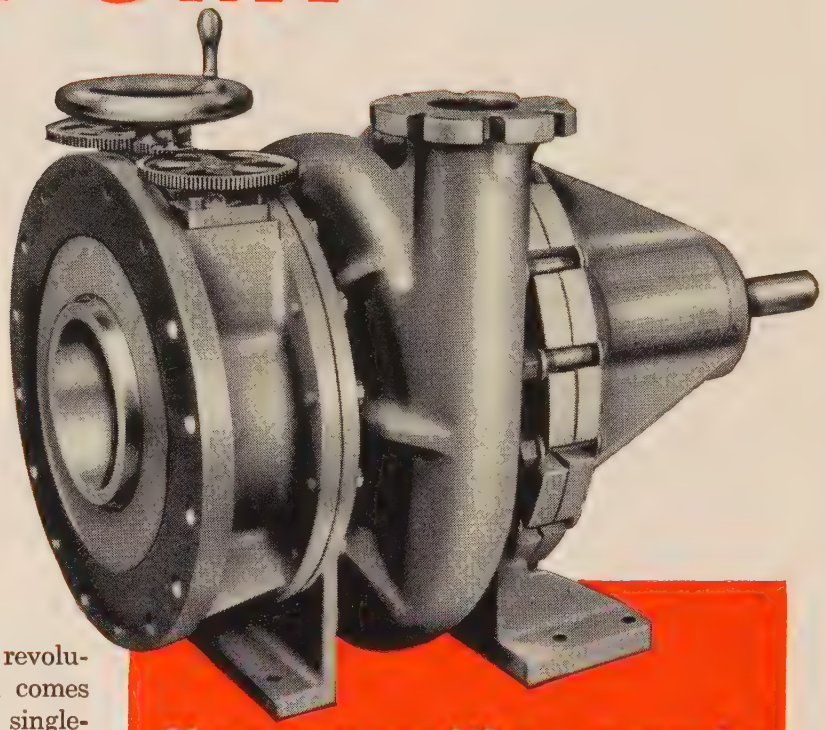
ALLIS-CHALMERS Paper Stock PUMPS



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New *ACAP* paper stock pumps feature a revolutionary new internal bypass control which comes bolted on in place of the suction flange of a single-suction pump.

Mere movement of its actuating mechanism (automatic or manual) slides the bypass cylinder toward or away from the impeller. See diagram. The clearance between the pump end of the cylinder and the impeller determines the amount of stock recirculation — regulates the flow at the discharge nozzle. With the cylinder at position *A*, recirculation is at a minimum, flow at a maximum. At position *B*, recirculation is at a maximum, flow is zero.

An infinite variety of intermediate settings between these two extremes provide variable control of capacity or head over the entire range of the pump — without any need to regulate the speed of the pump itself. Furthermore, it's now possible to buy an oversize pump and operate it with the bypass a little overset to maintain a degree of constant recirculation for blending.

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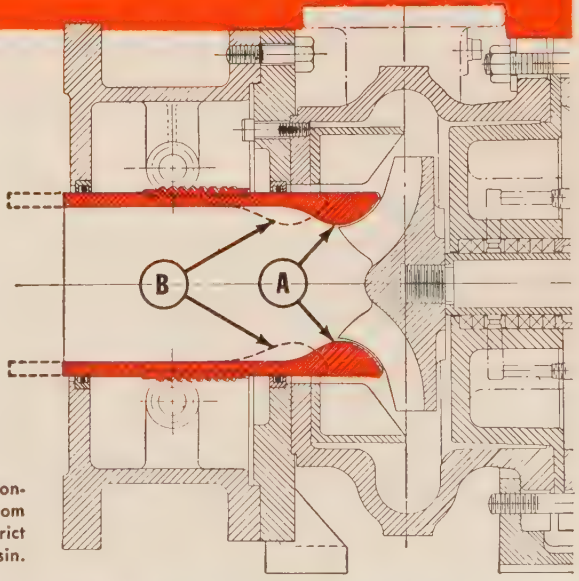

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the systems for book paper machines and other lightweight machines running on high speed have required similar changes.

In most mills the first indication of inadequate cooling has resulted in the generous use of mill compressed air supply to provide auxiliary cooling of certain high spots in calender rolls, which is an effective but expensive use of this compressed air that is almost always in short supply in a mill.

This paper discusses the various means in use for calender cooling starting with basic air supply from centrifugal fans and continuing with the use of compressed air, the use of relatively high pressure air though lower than compressed air services, and the method of supplying the air more effectively to calender rolls.

A further explanation is made of various methods of increasing the cooling effect starting with (1) the use of outside air from the mill rather than inside air and continuing on with (2) the use of cooling water available in mill supply, (3) the use of direct expansion refrigeration of the mechanical type, (4) the use of atmospheric air subjected to evaporative cooling equipment to utilize the wet bulb depression for lowering of the air supply air temperature supplied to the stacks, (5) the application of water sprays directly onto the calender rolls which has been practiced in some mills, and (6) the possibility of continuing on from this point to improve cooling in general.

The remote manual control of air supply to calenders on some machines is explained on the basis of designing equipment to make it easier for the operators to change the location of air application, which is particularly advantageous on newsprint machines where there is a continuously changing reel building problem that requires a great deal of effort at times on the part of the operator.

The Flow Properties of Paper Pulp Stock, II. The Relationship of Shear Value to Pipe Friction for Soda, Kraft, and Groundwood Pulp Slurries, by Richard E. Durst and Lyle C. Jenness, University of Maine, Orono, Me.

A correlation was found and has been reported previously which relates the laboratory measured shear value of bleached sulfate pulp to the pipe friction of the pulp slurries flowing through a piping system comprised of nominal 6-in. spiral welded steel pipe.

The correlation was obtained by first defining a dimensionless suspension flow number, N_{SF}. The N_{SF}, $D_V\rho/S$ was calculated from consistent units of pipe diameter, stock velocity, and stock density in slugs per cubic foot, and the shear value, S, measured in the viscosimeter also previously described.

A friction factor, f, calculated from measured head loss data by the familiar expression

$$\frac{\Delta H g D 2 g c}{u^2 L} = f$$

became a function of the N_{SF} so that a log-log plot of f vs. N_{SF} resulted, in which the data fell in a narrow band through which a single straight line could be drawn. The deviation of measured values from the straight line for the sulphite pulp was less than $\pm 7\%$.

More recent data of shear values and pipe friction show the correlation holds also for the three pulps: bleached soda, unbleached kraft, and unbleached groundwood. The soda and kraft pulps were pumped at consistencies between 2 and 5%, and velocities from 1 to 10 f.p.s. The groundwood was investigated only to a limited extent due to time limitations; however, the correlation seems to hold equally satisfactorily for the four pulps studied.

The Determination of Lengths of Straight Pipe Equivalent to Segmental Elbows in the Flow of Pulp Stock Suspensions, and the Effect of Location of Pressure Taps, by Richard E. Durst, University of Maine, Orono, Me., and Walter E. Pease, Great Northern Paper Co., Millinocket, Me.

An investigation was performed to determine the equivalent lengths of fittings expressed in feet of straight pipe for pulp suspensions and to study the effect of pressure tap location in the determination of these equivalent lengths. Bleached sulphite stock at 2, 3, and 4% consistencies was pumped through a 6.343-in. i.d. Armco spiral-welded steel pipe at various velocities.

The fittings under consideration were two $6^5/_8$-in. o.d. Armco segmental welded steel elbows arranged to form a U-bend having a vertical distance of 49 in. between the two horizontal legs. When pumping the 2% consistency stock through the system, it was found that the equivalent length in feet of pipe of an elbow was 30% greater than the equivalent length of pipe when using 3% consistency stock, and the equivalent length of pipe when using the 3% consistency stock was 17% greater than the equivalent length of pipe for the 4% consistency stock. It was also discovered that the location of pressure taps around the circumference of the pipe had an appreciable effect upon the results of this investigation.

How Should Maintenance Handle the Spare Parts Problem? by Keith C. Martiny, Kimberly-Clark Corp., Neenah, Wis.

Insurance is bought to prevent financial loss due to some unforeseen event. Spare parts, which are similarly used, are one of the forms of insurance used by manufacturing concerns.

The need for a spare part varies with the age of the equipment, the company policy on delay, and with the production demands on the machine.

The responsibility for supply of parts should rest with the plant engineer, he being the one best fitted to set up alternatives.

To keep spare parts in good control we should:

Select and design machinery so parts are interchangeable with those already in use.

Operate the machine on paper and set up protection for the early stages of actual operation.

Set up lubrication and preventive maintenance procedures and records.

Plan a program of repair in advance of the actual need and order parts accordingly.

Continuously change the parts protection to fit the mill policy on need, the service demanded, and tie in with available sources of supply.

Record and analyze delays, pin down the causes of trouble, and design them out of the machine.

Plant Visits

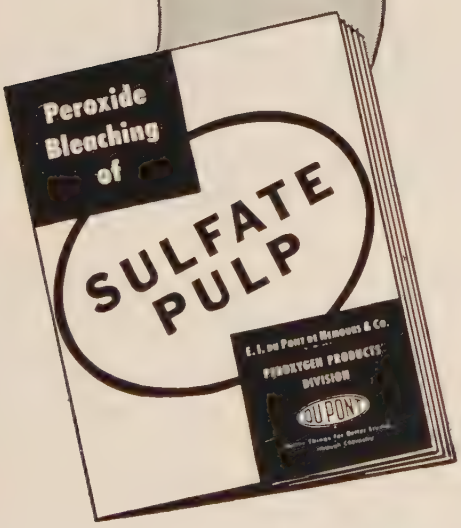
The principal plant visits on Thursday, October 21, will be to the Scott Paper Co., Chester, Pa., the General Electric Co., and the Westinghouse Electric Co. in Philadelphia. A special trip is also being arranged to the shop of Fischer & Porter Co. at Hatboro, Pa., manufacturers of control instruments chlorination equipment, and precision bore glass.

Members making the General Electric Co. trip will have an opportunity to see, in the process of manufacturing, assembling, and testing, switchgear equipments for utilities, transportation, and industrials, such as paper mills. The switchgear equipment ratings will cover a wide range in capacity from the lowest voltage up to 330,000 and in interrupting capacity up to 25,000,000 kva. which is the highest capacity now in commercial use. And as ratings up to 13.8 kv. are within the application range of paper mill service, a greater concentration of modern switchgear equipments within this range will be on display.

In the high capacity laboratory, in its control building, you will see its centralized control and instrumentation equipments which indicate and record every electrical phenomenon which proves or disproves the value of switchgear equipment

Bleach sulfate pulp

to an IMPROVED combination of brightness and strength



DU PONT PEROXIDE BLEACHING PROCESS

Many mills are meeting today's demand for high-quality kraft with the Du Pont Peroxide Bleaching Process. In this way, they can bleach sulfate pulp to a higher brightness and still maintain a proper balance of other desirable pulp characteristics.

For example, you can bleach your sulfate pulp to a higher brightness *with no undue loss in strength* or—you can produce a pulp having premium strength while keeping the brightness at its present level. It's easy and economical to produce whatever combination of brightness and strength characteristics you need with the Du Pont process.

Get all the facts about the new Du Pont Peroxide Bleaching Process. You can begin to profit from its many advantages almost immediately, for the process is easily installed—usually requires no major changes in present installations. Use the coupon below for your copy of our descriptive booklet or if you would prefer to talk it over with one of the Du Pont men who helped in the development of the process, just write to: E. I. du Pont de Nemours & Co. (Inc.), Peroxygen Products Division, Wilmington 98, Delaware.

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performance under short-circuit conditions. From these devices 400 miles of wire reach out to every device within the entire laboratory. In a matter of seconds a film record of electrical phenomena that took place in a switchgear interrupting device during a regular or short-circuit test is on the reading tables in the control room for observation.

Within the generator room are two huge generators, the largest ever built for short-circuit testing. They are designed to absorb the tremendous shocks produced during short-circuit tests. The stator of each generator is supported on huge-steel legs. Under the most severe short circuit, developing a whopping 8,000,000 ft.-lb. of torque, frame rotation is about $^1/_2$ in. each way at the point of attachment of the springs. These "legs" allow the stator to rotate through this small angle and still remain in perfect alignment with the rotor shaft. These spring legs take the brunt of the short instead of the windings under short-circuit conditions.

In the high-voltage yard you will observe huge power transformers capable of stepping up the voltage to 400,000 volts for testing circuit breakers and other equipments capable of harnessing and controlling the country's increasing electrical power needs. In the same area are capacitor banks for simulating actual conditions such as charging currents on high-voltage transmission lines up to 200 miles in length at 230,000 volts.

During this inspection trip within the laboratory, if conditions permit, an actual test will take place so as to simulate the magnitude of the tremendous electrical and mechanical forces developed under short-circuit conditions which must be dissipated by an interrupting device within a split second to protect the equipment on the line.

Switchgear circuit breakers capable of opening electric loads of 2,500,000 kva. must now be constructed to interrupt loads up to 25,000,000 kva.—ten times the previous ratings.

Reservations must be made at the Benjamin Franklin Hotel at the time of registration as accommodations are limited.

Eighth Alkaline Pulping Conference

The Eighth TAPPI Alkaline Pulping Conference will be held at the Dinkler-Tutwiler Hotel, Birmingham, Ala. on October 6–8, 1954.

Following is the tentative program:

Wednesday, October 6

Morning Session—9:30 a.m.

Moderator: K. D. Running, Halifax Paper Co., Roanoke Rapids, N. C.

1. "Correlation Between Chlorine Number and Lignin Content of High Yield Kraft Pulps," by E. L. Keller, Forest Products Laboratory, Madison Wis., and Peter B. Borlew, National Container Corp., Jacksonville, Fla.
2. "Utilization of Kraft Knotter Rejects," by R. E. Miller, J. J. Owen, Jr., and J. M. Piette, Union Bag & Paper Corp., Savannah, Ga.
3. "Sulphidity in Southern Pine Kraft Pulp," by K. G. Chesley and P. L. Gilmont, The Crossett Co., Crossett, Ark.
4. "Direct vs. Indirect Cooking for Pine and Hardwood Kraft Pulps," by Owen Hunter and Hansel Wade, Brunswick Pulp and Paper Co., Brunswick, Ga.

Luncheon—12:30 p.m. Speaker to be announced.

Afternoon Session—2:00 p.m.

Moderator: J. McK. Limerick, Bathurst Power and Paper Co.

1. "Interpretation of Cooking Charts from Direct Steamed Digesters," by John Morris, Armstrong College (formerly of Union Bag & Paper Corp.), Savannah, Ga.
2. "Instrumentation in the Cooking Process," by Fred Keyes, North Carolina Pulp Co., Plymouth, N. C.
3. High Yield Pulping Panel: J. McK. Limerick, Bathurst Power and Paper Co., Bathurst, N. B., Chairman; T. S. Coldeway, St. Joe Paper Co.; G. H. Whiteside, Container Corp. of America; David Weatherhorn, Southern Paperboard Corp., Port Wentworth, Fla.; L. M. Sutherland, Sutherland Refiner Corp., Trenton, N. J.

Agenda for Panel

1. Cooking: (a) Optimum Yield; (b) Control; (c) Chemical Consumption; (d) Chip Pretreatment.
2. Washing and Refining: (a) Preknotting; (b) Prerefining; (c) Pressure Washing.
3. Properties and Characteristics of High Yield Pulps.

Social Hour—6:00 p.m.

Thursday, October 7

Morning Session—9:00 a.m.

Moderator: K. G. Chesley, The Crossett Co., Crossett, Ark.

1. "Modified Permanganate Number for Partially Bleached Pulps," by Charles S. Benz, Scott Paper Co., Chester, Pa.
2. "Reuse of Knots and Shives for Bleached Kraft," by Albert L. Wiley, Riegel Carolina Corp., Acme, N. C.
3. "Instrumentation in Bleaching of Kraft Pulp," by A. P. Yundt, Camp Manufacturing Co., Franklin, Va.
4. "Preliminary Investigation on the Alkaline Pulping of Bamboo," by R. C. Sproull, Herty Foundation Laboratory, Savannah, Ga.

Luncheon—12:30 p.m.

Afternoon Session—2:00 p.m.

Moderator: H. Y. Charbonnier, Union Bag & Paper Corp., Savannah, Ga.

1. "Rapid Cycle Digesters," by L. E. Eberhardt, The Bauer Bros. Co., Springfield, Ohio.
2. "Kraft Pulping and Bleaching of Some Southern Hardwoods," by D. J. MacLaurin and J. R. Peckham, The Institute of Paper Chemistry, Appleton, Wis.
3. Semichemical Pulping Panel: C. W. Converse, Sprout Waldron Co., Muncy, Pa., chairman.

Friday, October 8

Visits to the University of Alabama Pulp and Paper School and the mills of the Gulf States Paper Corp., Tuscaloosa, Ala., and for the Coosa River Newsprint Co, Coosa Pines, Ala.

The conference committee chairmen are as follows: Local, Arrangements, R. R. Fuller, Gulf States Paper Corp., Tuscaloosa, Ala.; Program, H. Y. Charbonnier, Union Bag & Paper Corp., Savannah, Ga.

Ladies Program

For the ladies who attend the meeting there will be a get-acquainted luncheon on October 6, followed by a tour of the residential section of Birmingham via the Vulcan Trail, ending at 4:00 p.m. at the Bestavia Country Club.

On October 7 there will be a tour of the Fairfield Steel Works, Tennessee Coal & Iron Division, U. S. Steel Corp., followed by a bus trip to Red Mountain and the club for luncheon.

On Thursday, October 8, there will be a trip to Tuscaloosa Ala., to visit the campus of the University of Alabama.

TAPPI Fibrous Agricultural Residues Conference

The following news item was prepared by S. I. Aronovsky, Chairman of The Fibrous Agricultural Residues Committee. The conference is held, on alternate years at the Northern Regional Research Laboratory at Peoria. Since preparing this item Dr. Aronovsky has had to enter a

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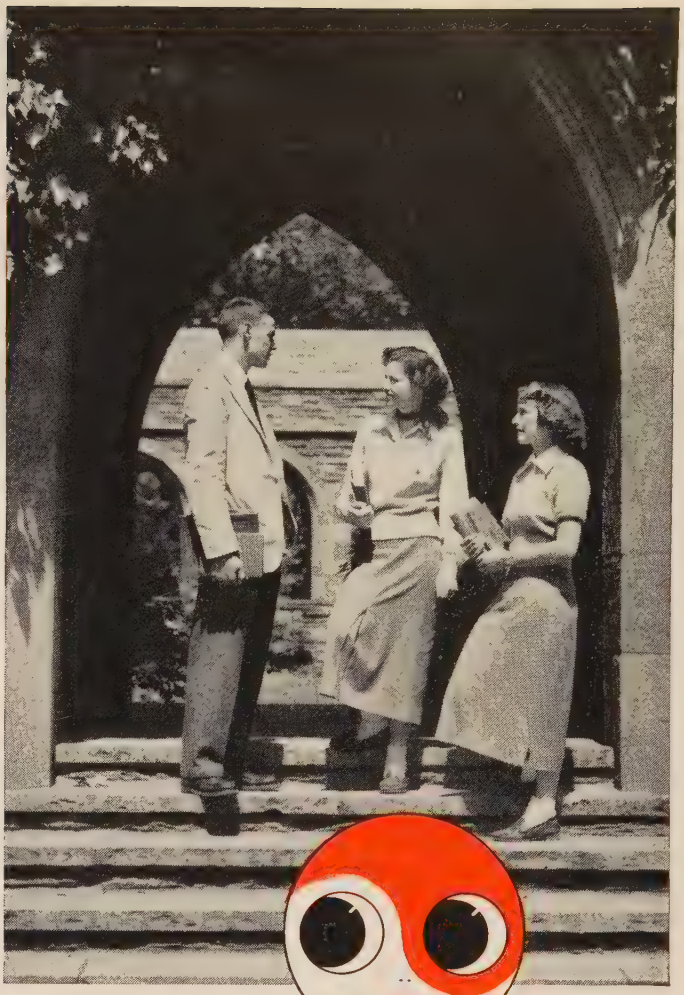

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hospital. Dr. Lathrop, his associate, will be in attendance at the FAO meeting in Buenos Aires at the time of the meeting. Since the principal hosts of this conference probably will not be in Peoria on November 8th and 9th there is a possibility that the conference will be cancelled. An official notice will appear in the October issue of *Tappi*.

The 11th annual TAPPI conference on fibrous agricultural residues will be held at the Northern Utilization Research Branch, formerly the Northern Regional Research Laboratory, Peoria, Ill., on November 8 and 9, 1954. Plans for this meeting are well under way. The two-day technical session will involve round-table discussions on "Interpretation of Strawboard Tests" and "Improving the Stiffness of Strawboard." These round-table discussions will be centered on lists of questions submitted by members of the TAPPI Fibrous Agricultural Residues Committee and by technical and operating personnel of the strawboard industry.

The special subcommittee appointed last year, consisting of J. R. Little, chairman, E. R. Carpenter, H. M. Blandin, J. J. Fiori, and W. D. Lewis, will report the findings at this meeting on their canvass of the strawboard industry for the feasibility of round-robin testing, among the strawboard mills, of the single flute and Concora flat crush testers for determining the crush resistance of corrugating board.

Discussion will also be held on reorganization of the TAPPI Fibrous Agricultural Residues Committee, of its projects, and of its subcommittees.

On Monday evening, November 8, the customary social hour and group dinner will be held. An outstanding interesting speaker is being lined up for this event.

Notice of this meeting and request for questions for the round-table discussions have already been sent to members of this Committee and to interested personnel of the strawboard industry. The usual good attendance and interesting discussions are expected at this 11th annual meeting sponsored by the TAPPI Fibrous Agricultural Residues Committee in Peoria.

International Mechanical Pulping Conference in 1955

The Second Mechanical Pulping Conference, jointly sponsored by the Canadian Pulp and Paper Association Technical Section and the Technical Association of the Pulp and Paper Industry, will be held at the Poland Spring House, Poland Spring, Me., on Sept. 19–21, 1955.

The 3-day technical program will feature regional comparisons of equipment and techniques used for the grinding and screening of mechanical pulp for various specific end-uses. Papers will also be presented on the latest innovations in the groundwood field, and delegates will visit groundwood mills in the Maine area. Chairmen of the two sponsoring committees are F. W. O'Neil, College of Forestry, Syracuse, N. Y., and T. G. Rust, Quebec North Shore Pulp & Paper Co., Baie Comeau, Que.

Stress-Strain Behavior Symposium

The Textile Division of the Massachusetts Institute of Technology Mechanical Engineering Department is sponsoring a two-day symposium on stress-strain behavior on Oct. 6 and 7, 1954, at Massachusetts Institute of Technology, Cambridge, Mass.

The topics covered in the symposium will not be confined to the subject of filamentous high polymers but will include a range of other material solids. It is hoped that such a diversified program will facilitate exchange of ideas among scientists and engineers whose work is supported by different industries.

Specifically, the symposium will deal with (1) recent developments in the techniques for obtaining stress-strain data and (2) advances in the interpretation and use of such data.

Wednesday, Oct. 6

"Linear Viscoelastic Behavior of Amorphous Polymers," by Dr. H. Leaderman, Rubber Section, National Bureau of Standards.

"Some Remarks on Non-Linear Stress-Deformation Relations," by Professor R. S. Rivlin, Department of Applied Mathematics, Brown University.

"Creep of Plastics for Different Types of Stresses," by Professor J. Marin, Head, Department of Engineering Mechanics, Pennsylvania State University.

"Creep of Metals,"* by Professor E. Crowan, Head, Materials Division, Department of Mechanical Engineering, Massachusetts Institute of Technology.

Thursday, Oct. 7

"A New Approach to Testing Fiber Arrays," by Dr. C. R. Stock, American Cyanamid Co.

"A New Extensometer for Films and Filaments," by Dr. C. H. Adams, Monsanto Chemical Co.

"Application of Stress-Strain Data to Specific Textile Engineering Problems," by Dr. W. J. Hamburger, Fabric Research Laboratories.

"Time and Temperature Effects on Stress-Strain Behavior of Fibrous High Polymers,"* by Dr. A. Brown, Carbide and Carbon Chemicals Co.

"Stress-Strain Data Utilized in the Design of Plastic Structures,"* by Professor A. G. H. Dietz, Head, Building and Construction Division, Department of Civil Engineering, Massachusetts Institute of Technology.

* Subject to change.

For further information, please contact Professor Stanley Backer, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Mass.

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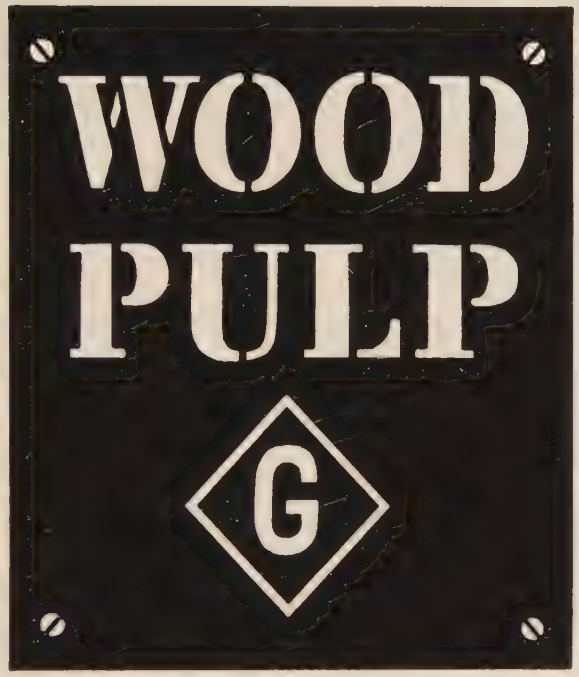

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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

William B. Ackley, Field Engineer, Fischer & Porter Co., Cincinnati, Ohio, a 1950 graduate of the University of Cincinnati.

Alexander A. Adamson, President and General Manager, Philippine Paper Mills, Inc., Manila, Philippines, a 1939 graduate of B.S.C. of Adamson University.

Leslie B. Baldwin, Plant Engineer, Brown Co., Berlin, N. H. Attended Carnegie Institute of Technology.

Clayton T. Bockus, Chemical Engineer, Eastern Corp., Bangor, Me., a 1927 graduate of the University of Maine.

Groff Collett, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., a 1949 graduate of Massachusetts Institute of Technology.

Janet Davidson, Librarian, Canadian Armament Research & Development Establishment, Que., P. Q., Canada.

John L. Dillon, Paper Chemical Salesman, American Cyanamid Co., New York, N. Y., a 1950 graduate of the University of Tennessee.

Donald J. Elliott, Plant Mechanical Engineer, American Box Board Co., Filer City, Mich., a 1947 graduate of Illinois Institute of Technology.

Nelson Emmons, Jr., Research Engineer, The Sheffield Corp., Dayton, Ohio, a 1927 graduate of Yale University.

Kenneth L. Fischer, Plant Chemist, Fonda Container Co., St. Albans, Vt., a 1952 graduate of New York State College of Forestry.

Pierre Georges Fould, Manager, Papeteries de Stenay, Paris, France.

Thomas R. Friedrich, Technical Director, The Beckett Paper Co., Hamilton, Ohio, a 1951 graduate of Massachusetts Institute of Technology.

Naohiko Fukui, Laboratory Worker, Mishima Seishi K. K. Suita Kojyo, Osaka, Japan. Attended Naniwa University.

Earl J. Gaudet, Superintendent, Standard Paper Mfg. Co., Richmond, Va.

Harmond W. Gerhart, Statistician, Scott Paper Co., Chester Pa., a 1948 graduate of the University of Pennsylvania.

John E. Griffith, Research and Development Chemist, Riegel Paper Corp., Milford, N. J., a 1953 graduate of New York University.

Harry E. Hadley, Mill Manager, The Gardner Board & Carton Co., Middletown, Ohio, a 1926 graduate of Institute of Industrial Arts.

Juremus Harms, Production Manager, Zellwolle Lenzing A/G, Lenzing, Austria, a 1935 graduate of the University with a Ph.D. degree.

Charles Holmgren, Chemist, American Bank Note Co., Bronx, N. Y., a 1949 graduate of Bard College.

Masahiro Ishihara, Director of Huji Mill, Honshu Paper Mfg. Co. Ltd., Shizuoka-ken, Japan, a 1935 graduate of Tokyo University.

Ford M. Jenkins, Research Director, O-Cel-O Div., General Mills, Inc., Buffalo, N. Y., a 1937 graduate of Vanderbilt University.

Matasaburo Kinoshita, Vice-President, Oji Paper Co. Ltd., Tokyo, Japan, a 1916 graduate of Tokyo University.

Kosoku Kobayashi, Director, Nagoya Mill, Honshu Paper Mfg. Co. Ltd., Nagoya, Aichi, Japan, a 1919 graduate of Kofu College.

John H. Kuhn, Technical Trainee, Lowe Paper Co., Ridgefield, N. J., a 1952 graduate of Rutgers University.

Jack M. Lamb, Resident Manager, St. Regis Paper Co., Tacoma, Wash.

Clifford Larson, Assistant Director of Research, Minnesota & Ontario Paper Co., Minneapolis, Minn. Attended the University of Minneapolis.

Milton A. Lefevre, Chemical Engineer, Sulphite Pulp Mfrs. Research League, Appleton, Wis., a 1936 graduate of the University of Wisconsin.

E. T. Lin, Mill Director, Lotung Pulp & Paper Mill, Lotung, Taiwan, China.

Charles A. Markee, Development Chemist, The Ohio Boxboard Co., Rittman, Ohio, a 1947 graduate of the University of Maine.

Anton A. Marvinney, Sales Service Engineer, Diamond Alkali Co., New York, N. Y., a 1951 graduate of Stevens Institute of Technology.

Francisco Masia, Manager, Feltrinelli Masonite S.p.A., Bolsano, Italy, a 1923 graduate of the Polytechnic Institute of Turin.

Kojo Matsumoto, Paper Testing Engineer, Shizuoka Kakoshi Kogyo Co. Ltd., Tokyo, Japan, a 1948 graduate of Tohoku Imperial University.

Victor F. Mattson, Research Chemist, Mead Corp., Chillicothe, Ohio, a 1954 graduate of the Institute of Paper Chemistry.

Arne M. Overgaard, Sales Engineer, A/S Lorentzen & Wettre, Oslo, Norway, a 1936 graduate of the Federal Polytechnic Institute, Zurich, Switzerland.

Albert S. Paye, Project Engineer, West Virginia Pulp & Paper Co., Luke, Md., a 1932 graduate of Rensselaer Polytechnic Institute.

Kenneth J. Reed, Chief Chemist, McCorquodale & Co. Ltd., London, E.C., England, a 1943 graduate of Imperial College of Science & Technology with a Ph.D. degree.

George W. Renninger, Supervisor of Physical Testing, American Viscose Corp., Sylvania Div., Fredericksburg, Va. Attended Bucknell University.

Frank A. Rideout, Development Engineer, Bakelite Co., New York, N. Y., a 1941 graduate of the University of Michigan.

William Robinson, Director, Richard Berg A/B, Stockholm, Sweden. Attended Chalmer's Technical College, Gothenburg.

John E. B. Sawyer, Assistant Chief Engineer, Brown Corp., LaTuque, P. Q., Canada, a 1943 graduate of the University of Manitoba.

Edwin K. Scholz, Assistant Pulp Mill Superintendent, West Virginia Pulp & Paper Co., Covington, Va., a 1940 graduate of Rensselaer Polytechnic Institute.

Roger A. Schwartz, Technical Director, Knowlton Bros., Watertown, N. Y., a 1934 graduate of St. Lawrence University.

Itsuro Senda, Chief Chemist, Kokuku Rayon & Pulp Co., Toyama Mill, Toyama, Japan, a 1937 graduate of Nigata University.

Irving D. Sisson, Chemical Engineer, Sorg Paper Co., Middletown, Ohio.

Albert Sonntag, Director, J. P. Sonntag G.m.b.H., Emmen-

How a Smallpox Epidemic Started the First Mass Production of Paper!

In A. D. 735 a smallpox epidemic struck Japan. To drive out the "evil spirits" believed to have been the cause of the disease, Empress Shōtoku sanctioned the printing of a million paper prayers. Each prayer was to be enshrined within an ornate wooden pagoda eight inches high and approximately four inches in diameter at the base. Requiring six years to complete, the project led to the first large-scale production of paper and to the world's first text printing upon sheets of paper. Just as this event contributed to the progress of paper-making, A. E. Staley Manufacturing Company promotes progress in modern papermaking by supplying high-grade raw materials to the nation's leading mills. Contact your supplier or write direct for details.

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dingen/Baden, Germany, a 1924 graduate of The Technical University, Darmstadt.

James C. Stinson, General Mill Superintendent, Fairfield Paper & Container Co., Baltimore, Ohio.

William A. Strickler, Sales Engineer, Pusey & Jones Corp., Wilmington, Del. Attended Syracuse University.

Kazuroku Suzuki, Director, Kumano Mill, Honshu Paper Mfg. Co. Ltd., Wakayamaken, Japan, a 1925 graduate of Kyoto University.

Akira Tamai, Director, Oji Paper Co. Ltd., Tokyo Japan, a 1921 graduate of Tokyo Technical College.

James O. Thompson, Research Chemist, International Business Machines Corp., Endicott, N. Y., a 1948 graduate of the University of Wisconsin with a Ph.D. degree.

Naoki Ueno, director, Edogawa Mill, Honshu Paper Mfg. Co. Ltd., Tokyo, Japan, a 1927 graduate of Kyoto Imperial University.

Paul D. Van Derveer, Technical Engineer, Johns-Manville Products Corp., Manville, N. J., a 1951 graduate of New York State College of Forestry.

John B. Verdon, Salesman, American Cyanamid Co., Kalamazoo, Mich. Attended Kalamazoo College.

Jean Paul Vilars, Chief, Research Laboratory, Papeteries Darblay, Paris, France.

Robert H. Walker, Electrical Superintendent and Instrument Supervisor, Eastern Corp., Bangor, Me., a 1942 graduate of the University of New Hampshire.

Erik A. Waller, Manager, Skoghall Works, Uddeholms A/B, Skoghall, Sweden, a 1932 graduate of the Technical University, Stockholm.

William E. Watson, Technical Supervisor, New Haven Board & Carton Co., New Haven, Conn., a 1948 graduate of Pennsylvania State College.

Theodore W. Welles, Production Engineer, Moser Bag & Paper Co., Cleveland, Ohio. Attended Cornell University.

Carl Wigger, Engineer, Heinrich Wigger & Co., Unna/Western Germany.

Murray Wolf, Chemist, Times Facsimile Corp., New York, N. Y., a 1949 graduate of Columbia University.

Frederic H. Yorston, Chemist, Pulp & Paper Research Institute of Canada, Montreal, P. Q., Canada, a 1923 graduate of McGill University with a Ph.D. degree in 1928.

TAPPI Notes

Richard F. Allen, formerly of Robert Gair Co., is now an Administrative Assistant with Sales Dept. of Hollingsworth & Whitney Co., Boston, Mass.

Oscar E. Anderson of the International Paper Co. has been transferred from Chisholm, Me., to New York City as Manager of the Service Dept.

Harold O. Balough, formerly of Hinde & Dauch Paper Co., is now Project Engineer for the West Virginia Pulp & Paper Co., Charleston, S. C.

Jesse E. Barnhart is now Chief Engineer of the Green Bay Paper & Pulp Co., Green Bay, Wis.

J. C. Barthel is now Technical Director of the Paper Chemicals Dept., American Cyanamid Co., New York, N. Y.

Arnold J. Bienfang, formerly of the Bienfang Paper Co., is now a Consultant for Industrial Package Engineering at 2302 E. Thomas Rd., Phoenix, Ariz.

J. Harold Brown, Research Chemist, Pulp Div., Weyerhaeuser Timber Co., has been transferred from Longview, Wash., to Everett, Wash.

Frank E. Caskey, formerly of the Crown Zellerbach Corp., is now with the Morden Machines Co., Portland, Ore.

Charles W. Cassell, formerly of the Everett Pulp & Paper Co., is now Assistant to the President of the Deerfield Glasine Co., Monroe Bridge, Mass.

Frank L. Cessna, Jr., formerly student at the New York State College of Forestry, is now a Chemist for the New York & Pennsylvania Co., Lock Haven, Pa.

Grellet N. Collins, Consulting Engineer, is now located at Rock Hall, Md.

Hilliard D. ("Dock") Cook has resigned his position as General Manager of Sweet Paper Co. and has established a consulting professional engineering business in Phoenix, N. Y. (P.O. Box 64).

John W. Crocker, formerly of the Sandy Hill Iron & Brass Works, is now in the Mechanical Engineering Div. of Stone & Webster Engineering Co., Boston, Mass.

William G. Dedert, Chemical Engineer for the Swenson Evaporator Co., has been transferred from New York City to Chicago, Ill.

George B. Downing is now President of the Downing Box Co., Milwaukee, Wis.

G. Milton Ellis, formerly of the Southern Paperboard Corp., is now Supervisor of Power for the Robert Gair Co., New York, N. Y.

Arthur R. Ewing, Director of the Paper Control Laboratory for Bemis Bros. Bag Co., has been transferred from St. Louis, Mo., to Boston, Mass.

Rodger L. Fife, formerly of the Southwest Corrugated Box Co., is now Production Development Engineer for the Central Fiber Products Co., Inc., Denver, Colo.

Basil S. Goerner, formerly student at the New York State College of Forestry, is now a Junior Technologist for the Champion Paper & Fibre Co., Pasadena, Tex.

W. H. Harding is now Director of Research for the National Gypsum Co., Buffalo, N. Y.

Harry Harmsen is now Production Manager of the Paterson Parchment Paper Co., Bristol, Pa.

F. Lier Harstad is now Manager of the Wall Board Plant for Berger Langmoen, Brumunddal, Norway.

J. J. Harrison is now General Manager of Harry T. Campbell Sons Corp., Towson, Md.

Robert G. Hitchings, formerly of the staff of the College of Forestry, State University of New York, is now a staff member at the School of Forestry, North Carolina State College, Raleigh, N. C.

Maung Sheve Htoo, formerly of the University of Maine, is now a Research Chemical Engineer for the International Paper Co., Glens Falls, N. Y.

Raymond S. Hatch, Director of Research for the Hudson Pulp & Paper Co., has been transferred from Palatka, Fla., to New York, N. Y.

Otto Heijne is now President of Munksjo A/B, Jonkaping, Sweden.

Herbert L. Hergert, formerly of the Oregon Forest Products Laboratory, is now a Research Chemist for Rayonier, Inc., Shelton, Wash.

H. O. Kaufmann is now a member of the Board of Directors of the Buffalo Electro-Chemical Co., Inc., Division of Food Machinery Corp., Buffalo, N. Y.

David P. Keefe, is now General Supervisor of Raw Materials for the Minnesota Mining & Mfg. Co., St. Paul, Minn.

Walter B. Kinney, formerly of the Borden Co., is now a Sales Representative in the Industrial Chemicals Div. of the Sheffield Chemical Co., Norwick, N. Y.

William D. Kohlins of the Buflovak Equipment Div., Blaw-Knox Co., has been transferred from New York City to Buffalo N. Y. as District Sales Manager.

Ralph W. Kumler, formerly of the American Cyanamid Co., is now Pulp and Paper Consultant for Foster D. Snell, Inc., New York, N. Y.

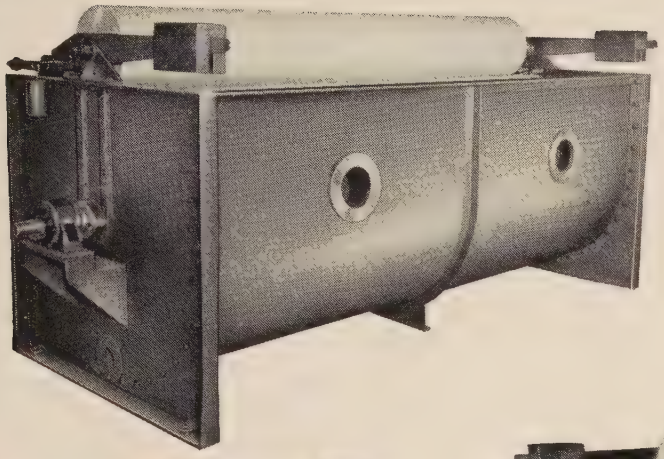
Robert T. Lacey is now Assistant Board Mill Superintendent for the Cellotex Co., Marero, La.

Norman S. Lea is now Technical Control Manager for the West Coast Div. Pulp Mill, Scott Paper Co., Everett, Wash.

John J. McNair, Research Chemist for the Pulp Div., Weyerhaeuser Timber Co., has been transferred from Longview, Wash., to Everett, Wash.

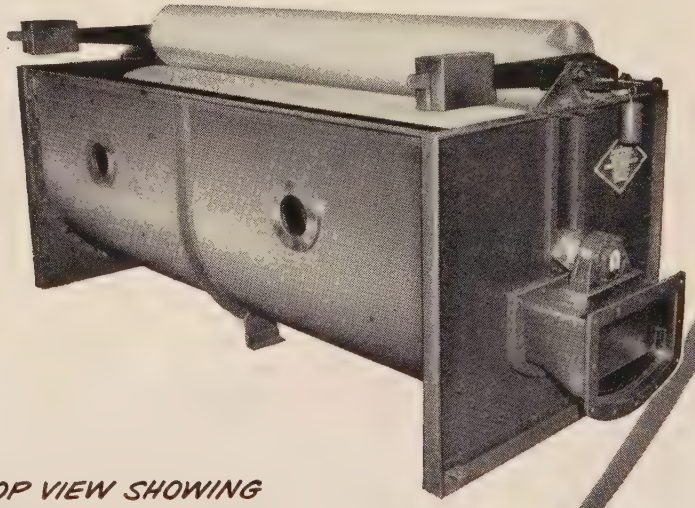
Kenneth L. Maves, formerly student at Western Michigan College, is now in the United States Army.

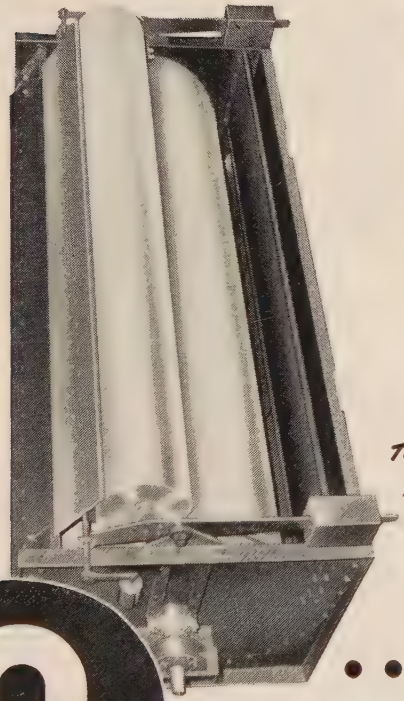
ANY WAY YOU LOOK AT IT...



VIEW OF END AND INTAKE SIDE OF COWAN DECKER

VIEW OF EFFLUENT DISCHARGE END FROM INTAKE SIDE





TOP VIEW SHOWING RUBBER-COVERED COUCH ROLL AND 48" DIA.— 131" CYLINDER MOULD

...the Cowan Decker shows its superiority!

COWAN DECKER PRODUCTION FIGURES:

35 tons/day — Groundwood
85 tons/day — Sulphite
100 tons/day — Kraft

APPLETON MACHINE COMPANY
APPLETON WISCONSIN

Exclusive U.S. licensee for Cowan Deckers

Charles H. Mahood, Jr., formerly student at the New York State College of Forestry, is now Assistant Control Supervisor for the Great Northern Paper Co., Millinocket, Me.

Horton Meyer is now Vice-President and General Manager of Cowles Co., Inc., Cayuga, N. Y.

William A. Moggio, formerly of the National Council for Stream Improvement, is now a Chemical Engineer with East Texas Pulp & Paper Co., Silbee, Tex.

Don H. Montville is now Sales Manager for Shartle Bros. Machine Co. Div., Black-Clawson Co., Middletown, Ohio.

William R. Nelson is now Technical Director of the Green Bay Paper & Pulp Co., Green Bay, Wis.

Edward H. Niederauer is now Division Manager of the Mead Corp. Chillicothe, Ohio.

Hugh C. Osborn, formerly of the R. T. Vanderbilt Co.. is now Technical Representative of the General Dyestuff Corp., Portland, Ore.

Harry S. Pedley, formerly of the Chase Bag Co., is now with the Champion Paper & Fiber Co., Pasadena, Tex.

A. W. Redlin, formerly of the Modena Paper Mills, Inc., is now General Superintendent of the Dunn Paper Co., Port Huron, Mich.

Clifford S. Reppe of the Hercules Powder Co. has been transferred from Akron, Ohio, to Holyoke, Mass., as Assistant District Sales Manager of the Paper Makers' Chemical Dept.

Edwin A. Riley is now President of the Record Foundry & Machine Co., Livermore Falls, Me.

McDewain Sandlin, formerly of the Gulf States Paper Co., is now Chief Chemist of the Rome Kraft Co., Rome, Ga.

David M. Shapleigh, formerly of the Jackson & Church Co., is now sales Engineer for Chemi-pulp Process, Inc., Watertown, N. Y.

John F. Shea is now Secretary-Treasurer of the Buffalo Electro-Chemical Co., Buffalo, N. Y.

George H. Sheets is now Assistant Division Manager of the Mead Corp., Kingsport, Tenn.

Bernard F. Shema, formerly of The Institute of Paper Chemistry, is now Chief Microbiologist for W. H. & L. D. Betz, Philadelphia, Pa.

C. P. Spring, formerly of the Chase Bag Co., is now Technical Director of Multiwall Products for the National Container Corp., Valdosta, Ga.

Harold R. Stoakes, formerly of the American Paper Converter, Howard Publishing Co., is now Editor of the *American Boxmaker*, Los Gatos, Calif.

Edward F. Thode, formerly Professor at the University of Maine, is now a Chemical Engineer for the Minnesota Mining & Mfg. Co., St. Paul, Minn.

Douglas M. Wallace, formerly student at the New York State College of Forestry, is now a Mill Apprentice at the S. D. Warren Co., Cumberland Mills, Me.

John E. Webb, formerly of Sonoco Products Co., is now General Manager of Sonoco de Mexico S/A, Mexico, D. F., Mexico.

Edward M. Williston is now Chief of the Applied Physics Section of the Development Dept. of Weyerhaeuser Timber Co., Longview, Wash.

James R. Wright is now Production Manager of the Green Bay Paper & Pulp Co., Green Bay, Wis.

W. A. Wylde is now Executive Vice-President of the Deerfield Glassine Co., Monroe Bridge, Mass.

* * *

L. P. Biefield, Manager of Research, has succeeded *G. de Piolenc* as the official representative of the Owens-Corning Fiberglas Co., Newark, Ohio, in the Technical Association.

In the reorganization of Canadian Industries, Ltd., Montreal, P. Q., the following TAPPI members are now employed by Du Pont Co. of Canada, Ltd.: *K. G. Aitken, A. J. Cameron, J. H. Hubel, W. J. Lovey, F. M. Languedoc*, and *D. E. Read.*

Industry Notes

PRODUCTION

Total production of paper and paperboard for the first six months of 1954 is estimated to have been 13,153,761 tons. This was 1.2 and 4.1% less for the same period in 1953 and 1951, respectively, when previous record highs were registered, and 8.1% more than 1952. This production of paper, including newsprint and building paper, for the year to date is 6,424,546 tons and that of paperboard including building board, 6,729,215 tons. Thus, it became clear, if further evidence was necessary, that in terms of tons produced, 1954 would be one of the industry's better years and that output for the year, on the basis of recent experience, should approximate, or slightly exceed, 26 million tons. Whether or not this is accomplished will depend in large measure on the levels of industry and trade in the last six months of the year. If, as many believe, the decline in business has reached its lowest point and in the months ahead will stabilize at the present or a slightly higher level, there should be an excellent chance of this coming to pass. If, however, the recent recovery is only of the moment, and the expected increase in activity is not realized, there is a good likelihood that production for the year will fall short of 26 million tons.

In June, production amounted to an estimated 2,220,000 tons, about 1% less than in May when production was slightly curtailed by the Memorial Day Holiday.

The production of printing paper, exclusive of newsprint, was 285,000 tons, a decrease of 5% from the May level. As a result, the manufacture of these papers during the second quarter, contrary to last year, was below that of the first quarter, indicating that the increase over 1953, shown in the accompanying table, is the result of gains achieved earlier in the year. However, new orders amounting to 296,000 tons, exceeded shipments for the first time since March, causing the backlog of orders to rise to 260,000 tons, 19% less than a year ago and equal to about 24 days' production.

Production of Paper and Board, First Six Months 1954 and Relationship to Production During the First Six Months of 1953, 1952, and 1951

	Production first six months 1954	*Per cent change from first six months*		
		1953	*1952*	*1951*
Group				
A—Printing and similar papers	1,799,066	+0.3	+ 1.7	+ 1.5
B—Fine papers	653,918	+0.6	− 7.2	− 3.5
C—Coarse papers	1,721,421	+1.3	+ 0.2	− 3.4
D—Tissue papers	798,016	+6.7	+19.1	+ 4.2
E—Miscellaneous papers	263,195	−8.5	− 3.6	− 6.9
F—Total groups A–E	5,235,616	+1.1	+ 2.0	− 0.8
Newsprint	561,158	+6.3	− 0.5	+ 1.9
Building paper	627,772	−3.7	+ 0.3	−19.9
Total paper	6,424,546	+1.0	+ 1.6	− 2.9
Paperboard	6,010,534	−3.6	+14.9	− 6.8
Building board	718,681	−0.6	+18.4	+ 9.6
Total board	6,729,215	−3.3	+15.2	+ 5.3
Total paper and board	13,153,761	−1.2	+ 8.1	− 4.1

Fine paper mills, by producing 111,000 tons, maintained a slight lead over last year despite the fact that production for the second quarter failed, by a small margin, to equal that of last year. The volume of new orders received, 109,000 tons, although larger than in recent months, was less than the tonnage shipped causing a slight reduction in the backlog of unfilled orders. The current backlog of orders estimated at 55,000 tons, was 8% below the level of a year ago and equal to about 13 days' production, on the basis of daily rate maintained in June.

The June production of coarse papers continued at about the May level and 283,000 tons of these papers were produced. However, while production was maintained, the

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A new 40-page manual gives a detailed review of modern high-density pulp bleaching processes with HYDROGEN PEROXIDE. Steep bleaching, continuous tower bleaching, pulp dryer bleaching, paper machine bleaching and steam bleaching, as applied to various pulps, are described. 11 schematic drawings illustrate the text. Send for Becco Bulletin No. 48.

Buffalo Electro-Chemical Company, Inc.
DIVISION OF FOOD MACHINERY AND CHEMICAL CORPORATION

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backlog of orders continued the slow decline which began in March and was estimated to have been 111,000 tons, equal to about 10 days' production, at the end of the month.

The production of tissue paper continued to be larger than that of 1953 as 129,000 tons were manufactured. In this segment of the industry, unlike the experience of other major classes, the first quarter advance over last year continued through the second quarter, causing output for the first six months to be about 50,000 tons more than for the first half of last year.

Production of paperboard increased for the third consecutive month as 1,034,000 tons are estimated to have been produced. As a result of the improved production in recent months, the position of this part of the industry in relation to other segments has shown steady, if small, improvement. Less encouraging was the fact that the volume of new orders received decreased from the May volume to 1,013,000 and, as a result, the backlog of unfilled orders decreased to 335,000, equal to slightly less than 9 days' production.

Paper and Board: Production by Grades, 1953, 1952, and 1951

(Tons of 2000 pounds)

	1953	1952	1951
ALL GRADES, TOTAL	26,458,781	24,422,785	26,048,143
PAPER, TOTAL	11,394,406	10,898,366	11,624,727
Newsprint, total	1,068,661	1,108,723	1,108,672
Standard	1,068,661	n.a.	n.a.
Super standard	...	n.a.	n.a.
Groundwood paper, uncoated, total	771,228	806,440	790,114
Groundwood publication and printing paper	600,031	588,575	518,748
Grade A	399,982	347,473	317,073
Grade B	200,049	241,102	201,675
Groundwood converting paper, total	142,746	170,466	219,356
Hanging	51,073	62,082	91,519
Box lining and covering	7,177	4,887	8,721
Body stock for coating	12,658	19,214	26,335
Body stock for carbonizing		3,453	5,656
Other converting, including drawing, tablet, album, etc.	71,838	80,830	87,125
Miscellaneous groundwood paper, total	28,451	47,399	52,010
Writing and mimeograph	9,616	18,626	22,641
Railroad manila	2,815	3,275	6,252
Poster	8,125	17,123	14,835
Other	7,895	8,375	8,282
Paper—machine coated printing and converting paper, total	1,182,150	1,096,251	1,112,990
Coated one side	100,247	79,897	89,086
Coated two sides	1,081,903	1,016,354	1,023,904
Book paper, uncoated, total	1,622,960	1,482,488	1,610,450
Book publication and printing paper, total	1,019,835	959,243	1,034,936
Plain	292,735	274,234	316,005
Supercalendered	358,869	338,614	357,776
Offset	331,535	316,527	328,621
Other book printing paper	36,696	29,868	32,534
Book converting paper, total	592,612	513,300	557,643
Body stock for coating	267,887	204,940	247,969
Envelope	173,212	161,539	165,545
Tablet	101,815	103,157	99,326
Other book converting paper	49,698	43,664	44,803
Miscellaneous book government postcard stocks	10,513	9,945	17,871
Fine paper, total	1,289,569	1,295,179	1,366,425
Writing paper, total	1,025,542	1,051,193	1,093,378
Writing, rag, total	122,904	132,097	160,889
Bond and writing, including protective and check	60,804	60,067	77,877
Ledger	12,759	18,467	21,771
Manifold	8,472	7,973	9,027
Papeterie and wedding	3,257	4,960	5,317
Map and chart	1,407	2,701	5,185
Reproduction	19,040	21,396	20,900
Index	7,731	7,891	11,116
Other[a]	9,434	8,642	9,696
Writing, chemical wood pulp, total	902,638	919,096	932,489
Bond and writing including protective and check	558,054	538,970	564,872
Ledger	38,069	39,693	45,818
Manifold	14,097	22,930	22,241
Mimeograph	80,254	97,227	84,743
Gelatin and spirit process duplicating	49,381	51,112	50,098
Papeterie and wedding	57,964	50,856	53,726
Map and chart	18,349	27,247	19,122
Blueprint and similar base stock	22,759		
Photographic and other sensitizing stock	22,672	40,670	35,783
Opaque circular	14,933	14,131	11,154
Other[b]	26,106	36,260	44,932
Bristols, except rag index and bogus, total	107,063	106,926	109,249
Index (chemical wood pulp)	83,398	84,932	84,199
Printing	18,873	15,623	17,418
Uncoated post card	4,792	6,371[c]	7,632[c]
Cover paper	39,679	34,484	38,059
Text paper	27,611	24,453	24,754
Colored school paper	2,740	1,671	6,238
Thin paper, total	86,934	76,452	94,747
Carbonizing, free from groundwood pulp	36,830	30,938	42,437
Condenser	50,104	35,926	39,885
Cigarette			
Other (stencil, lens, etc.)		9,588	12,425
Coarse paper, total	3,397,782	3,234,393	3,622,594
Unbleached kraft paper, total	2,578,188	2,366,306	2,622,641
Wrapping paper, total	429,374	361,297	378,641
M.F. and M.G. wrapping paper (colored or natural)	340,765	289,834	331,962
Butchers	48,126	71,463	46,679
Miscellaneous, including screenings, core stock, bogus, mill wrappers, car liners, and side rolls	40,483	[d]	[d]
Shipping sack paper, total	667,899	716,252	805,534
Shipping sack paper, meeting minimum standards Federal Spec. UU-S-48	606,830	681,390	773,851

Portrait of Progress

FIRST INSTALLATION OF A SPECIALLY-ENGINEERED SPINNING FRAME AT THE LOCKPORT FELT COMPANY

A NEW DEVELOPMENT IN FELT MAKING

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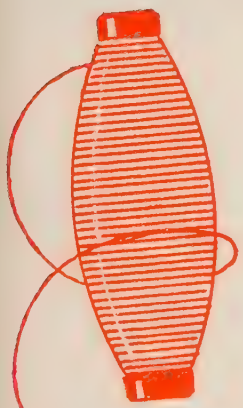

A long-standing Lockport Felt Company policy directs that whenever possible **every** component of **every** TENAX FELT be produced in the Lockport plant. From sorting the raw wool to the completion of the finished felt, wool felts are ALL-LOCKPORT . . . QUALITY-CONTROLLED in every step of their manufacture.

Now, this rigid control of quality is applied to the production of **worsted yarn.** More than two years of research and planning . . . by Lockport technical experts collaborating with the Research Division of the Whitin Machine Works . . . resulted in the development of the Worsted Spinning Frame shown above. This new Spinning Frame, together with other machines shown for the **first time** at the Textile Machinery Show in Atlantic City on April 26th, had been in operation at Lockport since early 1954. This is the first application to the production of paper-makers felts.

Let your Lockport Felt Company representative show you why TENAX FELTS . . . made by the **only** felt-manufacturer with facilities to produce **both** woolen and worsted yarns . . . can serve you better.

LOCKPORT FELT CO.

NEWFANE, NEW YORK

TENAX FELTS

Paper and Board: Production by Grades, 1953, 1952, and 1951 (Continued)

(Tons of 2000 pounds)

	1953	1952	1951
Other unbleached kraft shipping sack paper	61,069	34,862	31,683
Bag paper, total	894,749	748,929	789,833
Grocers and variety bag paper	850,807	720,178	752,122
Other unbleached kraft bag paper	43,942	28,751	37,711
Converting paper, total	586,166	539,828	648,633
Asphalting paper, including creped or creping stock for asphalting	203,643	169,786	213,237
Other creping	29,624	21,908	32,808
Envelope stock	65,943	58,803	65,499
Gumming stock	87,113	79,152	98,850
Twisting and spinning stock (18 lb. and up)	25,137	25,135	30,269
Waxing stock (18 lb. and up)	26,985	22,404	32,051
Other converting paper	147,721	162,640	175,929
Rope and combination kraft and rope shipping sack paper	9,463	11,481	13,356
Glassine, greaseproof, and vegetable parchment, total	148,859	138,083	178,269
Wrapping paper	79,475	82,381	96,420
Bag stock	20,402	9,279	7,402
Converting stock	48,982	46,423	74,447
Other coarse paper, including bleached and semibleached kraft paper, sulphite, and any mixed furnishes containing not more than 50% unbleached sulphate wood pulp, total	661,272	718,523	808,328
Wrapping paper, total	210,817	290,659	326,243
M.F. and M.G. wrapping paper (colored or natural	40,877	65,390	75,448
Butchers and grocers wrap	133,255	159,762	168,404
Miscellaneous, including screenings, core stock, bogus, mill wrappers, car liners, and slide rolls	36,685	65,507[d]	82,391[d]
Shipping sack paper	33,482	25,566	30,422
Bag paper, total	49,262	46,184	48,163
Grocers and variety bag paper	26,199	46,184	48,163
Other bag paper	23,063		
Converting paper, total	367,711	356,114	403,500
Envelope stock	53,498	46,927	46,814
Gumming stock	7,124	4,429	2,850
Twisting and spinning stock (18 lb. and up)	10,096	11,841	6,392
Waxing stock (18 lb. and up)	177,103	210,847	253,715
Cup stock (under 90 lb.)	35,466	28,929	30,472
Asphalting paper, including creped or creping stock for asphalting	9,112	53,141	63,157
Other creping	3,189		
Other converting paper	72,123		
Special industrial paper (all weights and calipers), total	553,396	517,244	540,450
Abrasive paper	8,772	7,204	11,462
Cable paper	17,079	16,534	14,670
Electrical insulation and armature paper and paperboard	16,713	11,901	15,075
Gasket paper and paperboard	5,185	3,688	5,776
Stencil backing paper and stencil board	3,202	3,868	6,016
Tabulating card stock	118,653	120,212	118,748
File folder stock	25,718	36,482	26,618
Tag stock	104,507	104,889	113,412
Wallet and patch stock	4,729	8,382	8,238
Pressboard, including imitation pressboard	14,890	11,250	15,280
Tympan	3,103	3,492	4,478
Blotting paper	9,301	10,575	13,569
Filter paper	11,429	9,395	11,408
Matrix paper and board	10,051	9,073	9,282
Vulcanizing fiber stock	28,668	26,262	31,984
Resin impregnated stock	30,845	33,181	43,785
Die wiping stock	4,762	3,693	4,644
Other special industrial or absorbent paper	135,789	97,163	86,005
Sanitary tissue stock, total	1,277,494	1,148,467	1,243,858
Sanitary napkin stock wadding	33,632	[d]	[d]
Toweling stock, total	296,752	275,460	289,611
Industrial (bulk and dispenser types)	206,273	202,234	219,394
Household (retail packages)	90,479	73,226	70,217
Toilet tissue stock, total	607,159	540,255	600,382
Regular type—single ply	441,628	412,156	475,063
Facial tissue type—2 or more ply	165,531	128,099	125,319
Napkin stock, total	88,695	79,222	82,209
Industrial (bulk and dispenser)			
Regular type—single ply	72,656	72,406	75,890
Facial tissue type—2 or more ply	16,039	6,816	6,319
Resale (retail packages), total	78,675	60,481	53,920
Regular type—single ply	56,287	51,812	47,843
Facial tissue type—2 or more ply	22,388	8,669	6,077

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IN TUB AND CALENDER SIZING

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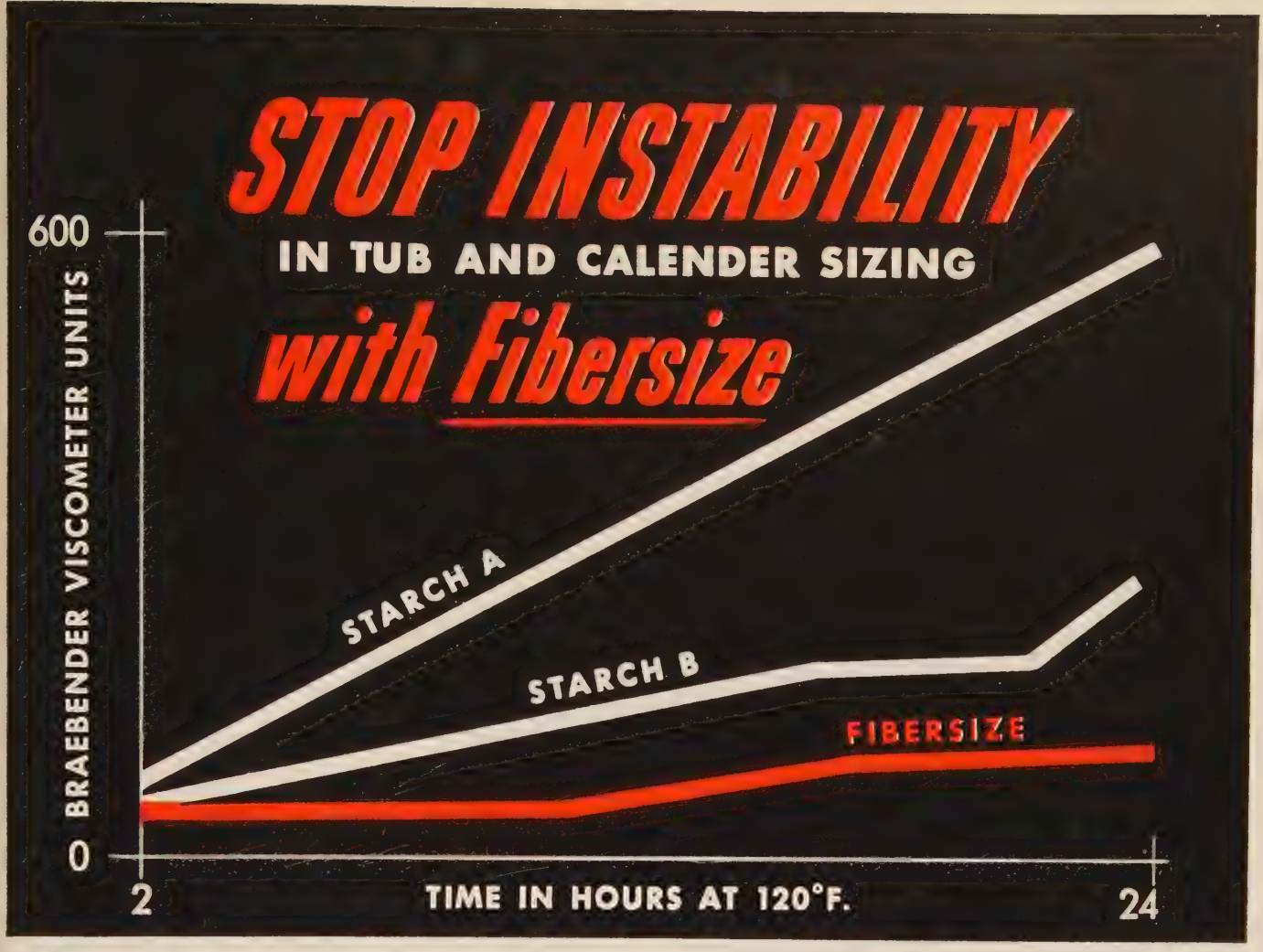

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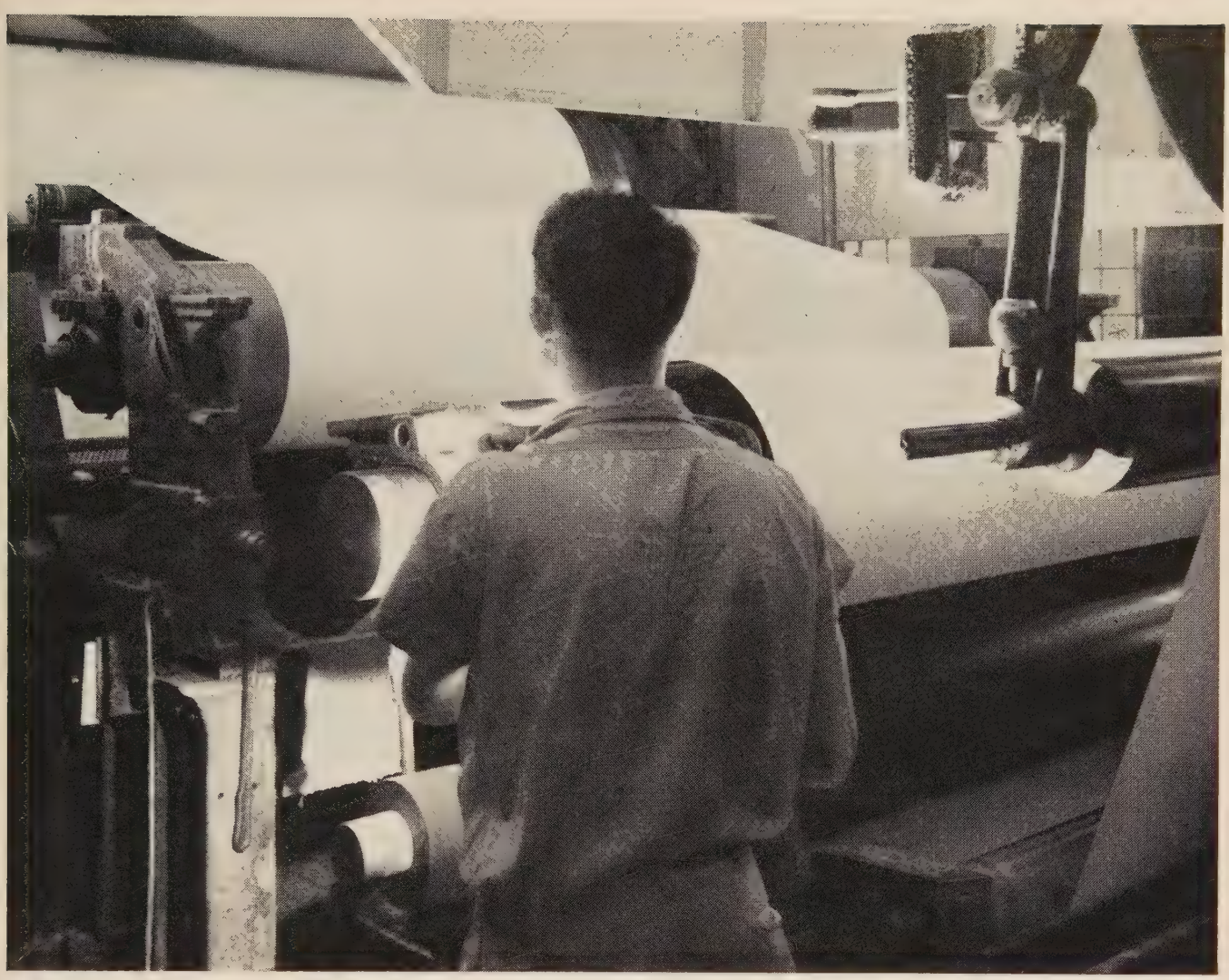
National
STARCH PRODUCTS

Paper and Board: Production by Grades, 1953, 1952, and 1951 (Continued)

(Tons of 2000 pounds)

	1953	1952	1951
Facial tissue stock (other than napkin and toilet stock)	164,314	149,686	167,836
Other sanitary tissue	8,267	[d]	[d]
Tissue paper, except sanitary and thin (all weights under 18 lb., 24 × 36—480), total	231,166	209,181	229,174
Wrapping tissue	51,727	52,550	63,489
Waxing tissue stock	99,027	83,210	76,982
Twisting tissue stock	14,393	11,544	16,596
Fruit and vegetable wraps	26,452	23,350	31,158
Pattern tissue stock	6,761	7,525	9,135
Sales-book tissue stock	1,272	873	1,736
Crepe wadding for packing	21,732	21,219	30,078
Other	9,802	8,910	
PAPERBOARD, TOTAL	12,220,162	10,771,806	11,620,048
Container board, total	6,613,206	5,766,462	6,322,782
Liners, total	4,410,710	3,901,682	4,213,328
Kraft	3,567,767	3,056,661	3,077,666
Jute	840,870	821,050	1,114,802
Other liners	2,073	23,971	20,860
Corrugating material, total	1,906,116	1,583,046	1,784,163
Kraft	311,085	257,938	277,292
Straw	302,806	300,377	345,426
Semichemical	970,483	738,320[e]	789,634[e]
Other corrugating material, including bogus	321,742	286,411[f]	371,811[f]
Container chipboard, total	296,380	281,734	325,291
Solid fiber board, for filler board	191,606	178,224	208,015
Other container chipboard	104,774	103,510	117,276
Bending board, total	3,566,528	3,144,225	3,271,579
Folding boxboard stock, total	2,443,574	2,192,903	2,362,356
Unlined chipboard	383,938	423,542	427,745
Single and double manila lined chipboard	734,915	675,508	725,252
Single and double lined chipboard, except manila	289,982	254,387	318,320
Patent coated, all types	609,884	494,497	562,374
Clay coated	150,266	115,311	118,709
Other machine coated boxboard	118,672	99,546	90,267
Other folding boxboard stock	155,917	130,112	119,689
Special food board, total	956,765	799,280	772,541
Milk bottle stock	356,100	301,579	259,062
Milk bottle hood and lip cover stock	12,455	21,021	36,057
Liquid tight container stock	45,060	75,493	56,643
Cup lid stock	26,379	16,374	16,359
Cup and round nested food container stock (90 lb. and up)	156,090	112,848	129,029
Milk bottle plug stock	15,788	19,696	19,276
Ice cream and food pail stock	27,724	16,798	26,654
Plate, dish, and tray stock	52,264	31,367	27,872
Frozen food container stock	65,243	46,230	51,691
Butter, oleo, shortening, and ice cream carton stock	155,697	131,262	122,520
Other special food board container stock for liquid, moist, or oily foods	43,965	26,612	27,378
Other bending board, total	102,479	97,356	98,802
Unlined chipboard	47,825	40,900	22,287
Single and double manila lined chipboard	36,727	14,938	16,784
Single and double lined chipboard, except manila	8,388	10,718	12,336
Patent coated, all types	9,539	21,707	28,830
Clay coated	...	9,093	18,565
Other machine coated	...		
Solid chemical pulp and lined manila board (except special food board)	26,184	39,835	21,437
Other bending board	37,526	14,851	16,442
Nonbening board, total	897,681	782,911	876,792
Setup boxboard, unpasted, total	733,766	687,599	736,311
News lined chipboard	603,681	579,468	598,663
Other lined and unlined chipboard	86,284	52,132	88,522
Solid newsboard	20,613	25,586	23,811
Strawboard, including straw combinations	...	30,413	...
Other setup boxboard	23,188		25,315
Other nonbending board, total	163,915	95,312	140,481
Lined and unlined chipboard, total	126,109	58,086	94,388
News lined	89,424	23,212	61,657
Other lined and unlined chipboard	36,685	34,874	32,731
Solid newsboard	6,796	5,131	6,976
Strawboard, including straw combinations	6,118	6,915	9,927
Other nonbending board	24,892	25,180	29,190
Special paperboard stock, total	1,071,032	1,008,801	1,063,597
Tube, can, and drum stock			
Tube stock	223,644	231,318	240,817
Can stock	47,491	68,840	84,896
Drum stock	54,271		
Solid wood pulp board (groundwood)	11,233	10,006	10,433
Match board	41,176	35,829	37,963
Egg case filler board	22,937	31,806	32,690
Panel board	50,073	40,539	37,710
Building board stock			
Liner for gypsum and plaster board	458,572	432,502	458,233
Laminated wallboard stock	46,475	44,177	49,233
Other building board stock	23,820	18,624	20,168
Other special paperboard stock	91,340	95,160	91,454
Cardboard, total	71,715	69,407	85,298
Uncoated mill blanks and clay coated blanks	22,403	21,845	28,888
Clay coated tag stock	1,493		
Photomount stock	5,873	5,171	5,906



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Paper and board: Production by grades, 1953, 1952, and 1951 (Continued)

(Tons of 2000 pounds)

	1953	1952	1951
Bogus bristol	16,760	15,920	21,083
Playing card stock	7,878	7,318	7,861
Railroad and poster manila	5,698	6,550	21,560
Coated bristol or post card stock	11,610	12,603	
Other cardboard			
WET MACHINE BOARD, TOTAL	155,261	139,005	148,381
Binders' board	42,685	37,335	41,240
Shoe board	50,640	49,718	46,690
Other wet machine board	61,936	51,952	60,451
CONSTRUCTION PAPER AND BOARD, TOTAL	2,688,952	2,613,608	2,654,987
Construction paper, total	1,312,972	1,298,799	1,385,691
Sheating paper	17,673	18,078	19,634
Felts, saturating and dry			
Roofing felts	1,001,530	986,061	1,055,307
Floor covering	136,297	150,667	141,168
Automotive felts	47,968	36,282	35,672
Other felts	28,564	16,495	24,422
Asbestos paper and asbestos filled paper	65,064	74,000	89,493
Flexible wood fiber insulation	15,876	17,216	19,995
Other construction paper			

	1953		1952[g]		1951[g]	
	Short tons	M square feet, 1/2 in. basis	Short tons	M square feet surface measure	Short tons	M square feet surface measure
Insulating board and hardboard (not laminated), total	1,375,980	3,653,599	1,314,809	3,244,861	1,269,296	3,184,302
Insulating board, density 26 lb. or less per cu. ft., total	952,562	2,427,791	879,655	2,242,207	925,744	2,382,880
Building board, natural	76,234	226,576	103,181	268,246	172,291	450,018
Lath for plaster base	3,503	9,648	25,782	64,165	40,316	103,812
Roof insulation board	129,662	364,184	84,476	187,167	81,614	180,010
Insulating roof deck	15,828	38,260				
Interior board, factory finished, total	303,935	822,640	311,725	825,688	305,242	827,598
Board	76,794	208,483	148,430	391,413	151,604	417,844
Panel and tile except acoustical	125,984	331,409	144,384	379,244	134,627	357,761
Acoustical tile	55,658	162,167				
Plank	22,156	59,762	18,911[h]	55,031[h]	19,011[h]	51,993[h]
Other (trim, molding, etc.)	23,343	60,819				
Sheathing board	233,912	510,447	194,034	457,558	170,277	393,390
Insulating side base	110,466	249,202	122,747	324,041	115,780	309,507
Shinglebacker	13,346	37,983	...	...	...	...
Thinboard (7/16 in. or less)	15,028	47,777	26,579	84,622	28,566	92,172
Other insulating board	50,648	121,074	11,131[i]	30,721[i]	11,658[i]	26,373

	1953		1952[g]		1951[g]	
	Short tons	M square feet 1/8 in. basis	Short tons	M square feet surface measure	Short tons	M square feet surface measure
Wood fiber hardboard, density over 26 lb. per cu. ft., total	423,418	1,225,808	435,154	1,002,654	343,552	801,422
Treated or tempered	210,777	610,626	435,154	1,002,654	343,552	801,422
Not treated or tempered	212,641	615,182				

[a] Fine paper: "Mimeograph, gelatin and spirit process"; and "Drawing, mechanical, and detail" included in "Other rag writing."
[b] Fine paper: "Drawing mechanical and detail" included in "Other chemical wood pulp writing."
[c] Fine paper: Tonnage reported as "Other bristols, except rag index and bogus" included in "Uncoated post card."
[d] In 1951 and 1952 "Miscellaneous, etc." unbleached kraft wrapping was included with "Miscellaneous, etc." other wrapping.
[e] Reported as "Corrugating, other than Kraft, straw, or bogus."
[f] Reported as "Bogus corrugating."
[g] In 1951 and 1952 the distinction between insulating board and hardboard was defined at 24 lb. per cu. ft.
[h] Included under "Other insulating board."
[i] Includes other interior board, e.g., trim, molding, etc.

PULPWOOD

Total pulpwood receipts for the January–May period this year were 11,107,000 cords, an increase of 271,000 cords over receipts for the comparable period last year. Increases were recorded in the Northeast, Lake States, and Pacific Regions of 2, 18, and 8%, respectively, while nominal declines of 1 and 2%, respectively, were reported in the Southern and Appalachian Regions.

Consumption continued high in May, the largest increase for the January–May period being reported from the Pacific Northwest. Small decreases were recorded in the Northeast and Lake States Regions. Total consumption for 1954 through May, was 11,877,000 cords, an increase of 179,000 cords over the comparative months last year.

Pulpwood inventories at the end of May, 4,868,000 cords, reached their lowest point since August, 1951. In comparison to inventories at the end of April, the decline was 412,000 cords. Each region showed a decline, the largest, 171,000 cords, being reported in the Northeast.

WOOD PULP

Average monthly wood pulp production for the first five months of this year was 26,000 tons higher than for the same period last year. For the January–May period, production was 7,433,000 tons in comparison to 7,305,000 tons produced in the same period last year. This increase was primarily due to the expansion of existing production facilities, since the output of new mills which have recently begun operations is not yet reflected in statistics of the industry.

Consumption of wood pulp for 1954 through May, was only slightly higher than consumption for the same months last year. By the end of May, 7,784,000 tons of wood pulp had been consumed, 2000 tons above consumption for the comparable period last year.

Imports of wood pulp through May, totaled 799,129 tons, a decrease of 97,428 tons imports for last year. Imports from abroad declined 44% or 110,392 tons, while imports from Canada increased 2% or 12,964 tons.

Exports of wood pulp continued high, averaging 21,000 tons monthly for the first five months of this year compared to an average of 10,000 tons monthly for the comparable period in 1953.

Inventories of wood pulp at the end of May were 669,000 tons, an increase of 13,000 tons over inventories at the end of

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April—pulp mill inventories increased 17,000 tons and paper and board mill inventories declined 4000 tons. At the end of May, inventories at pulp mills were 176,000 tons and at paper and board mills, 493,000 tons.

Wastepaper

Estimated consumption of wastepaper during the first half of this year in the United States amounted to 4,006,000 tons, approximately 340,000 tons less than was consumed in the first six months of last year. It was, however, the third highest first half year on record, only last year and 1951 exceeding 4,000,000 consumption in a year's first half. Wastepaper consumption during this year's first half is estimated as follows: by paperboard mills, 3,025,000 tons; by paper mills, 581,000 tons; by building materials and wet machine board mills, 400,000 tons.

Sixty-five Billion Milk Cartons

At ceremonies in Washington recently, Agriculture Secretary Benson was presented with the 65 billionth milk carton, to commemorate the twentieth anniversary of the introduction of cartons in the dairy industry. Dairy industry leaders attending the ceremony estimated that half of the nation's beverage milk would be packaged in containers this year.

Newfoundland

Employing 12,000 mill and woods workers, the pulp and paper industry today is Newfoundland's prime earner. Last year, the industry's products were worth $39,700,000, an increase of $5,200,000 over 1952; and production was equal to 19% of the total provincial income.

Denmark—United Paper Mills

The first paper mill to be established in this country was built in the year 1576 at Hvidøre near Copenhagen. During the following centuries several mills were built in various parts of Denmark, and about 1850 the number of mills had increased to twenty, the best known mill being the one at Strandmøllen, where the well-known Drewsen family resided from 1690 to 1889. The history of this enterprising family gives a very interesting glimpse of old time papermaking—from handicraft to the machine age.

In the course of the following 30 or 40 years the number of mills was reduced to ten, but even this was too much for the country, the market being too small to allow for a profitable working of so many factories. The competition had increased considerably after the introduction in Denmark in 1829 of the paper machine, and to this must be added that there was no attempt at a division of the work between the mills, all the mills producing more or less the same qualities of paper.

Most of the mills therefore suffered from financial difficulties, and as a result it was determined in 1889 to establish a/s De Forenede Papirfabrikker (United Paper Mills, Ltd.).

At the beginning this merger comprised eight paper mills, namely: Strandmøllen, Orholm, Silkeborg, Dalum, Maglemølle, Havreholm, Nørrebro, and Haraldskjær.

During the following years a strict rationalization was carried through. The mills with the lowest earning power and in the most inaccessible situations were closed down and sold to be used for other purposes, while with regard to the remaining mills the production was organized so as to obtain a more convenient distribution of the different qualities between the individual mills. Since the start of the company another two mills have been included, and De Forenede Papirfabrikker now (1951) comprises the following six mills: Dalum Papirfabrik near Odense, Frederiksberg Papirfabrik in Cophenhagen, KøbenhavnsP apir - & Karton-Fabrik in Copenhagen, Gamle Maglemølle Papirfabrik at Næstved, Ny Maglemølle Papirfabrik at Næstved, Silkeborg Papirfabrik at Silkeborg.

The two mills in Cophenhagen are both equipped for converting wastepaper into cheap wrappings and nine-point for corrugatings and boards. The water for the manufacturing process is supplied partly from borings and partly from the Copenhagen Water Works, and waste water is discharged into the Copenhagen sewage system.

The remaining four mills are situated in the provinces at water courses from which the water for the manufacturing process is taken and into which the waste water is discharged. When the mills were started, a considerable part of the power required was provided by hydraulic turbines. These now cover only a negligible part of the total power requirement.

The total annual output from our six mills is about 100,000 tons of paper and board comprising a little more than 300 different qualities. Besides De Forenede Papirfabrikker the paper and board industry in Denmark comprises another six factories with a total annual output of about 10,000 tons of boards and wrappings.

The annual consumption of paper and board in Denmark is about 250,000 tons—per inhabitant the consumption is about 60 kg. annually—a figure which is exceeded by very few countries. As already mentioned the home production amounts to about 110,000 tons annually, while the remaining consumption is covered chiefly by import from the other Scandinavian countries. Among the imported qualities newsprint amounts to about 50,000 tons annually, this quality being only to a small extent manufactured here. The rest of the import comprises our qualities and some specialities not produced in Denmark.

The bulk of the raw materials used is imported: cellulose and groundwood from Finland, Norway, and Sweden, resin from Portugal, France, and the U.S.A., and better grade china clay from England. A minor part of the groundwood consumed is, however, produced in two plants at Dalum and at Maglemølle, and china clay for paper which need not be perfectly white is obtained from the Danish island Bornholm.

At the foundation in 1889 the share capital of De Forenede Papirfabrikker amounted to 2.5 million kroner, the share capital has since then been increased several times—most recently in 1950—and by now it amounts to 21 millions.

At present (1951) the salaried staff of the six mills numbers about 350 persons, while the number of workers employed is 2220.

Following are brief descriptions of the individual mills of a/s De Forenede Papirfabrikker (United Paper Mills, Ltd.), 18, Store Strandstræde Copenhagen, K.

Dalum Papirfabrik. This mill was built in 1874 at the river which flows through the town of Odense, and at the time of the merger it was equipped with two paper machines.

Now it has five paper machines and a groundwood plant. The output is about 21,000 tons of writings, printings, and magazine paper.

The number of people employed in this mill is 550.

Frederiksberg Papirfabrik. The year of foundation of this mill is 1881, and for a number of years its owners were the Ferslew family who wished to produce their own newsprint for the newspapers published by the Ferslew concern. In 1931 our company took over the mill with its two paper machines which are now used for the conversion of waste paper into wrappings and nine-point chips.

The staff and workers number about 150 persons.

Kobenhavns Papir- & Karton-Fabrik. In order to utilize wastepaper more rationally the above mill was built in 1933 to replace the obsolete Nørrebro Papirfabrik which was closed down simultaneously.

From this raw material the mill produces annually about 14,000 tons, nine-point chips, news line chip boards, and testboards for corrugating.

The number of people employed is about 200.

Gl. Maglemolle Papirfabrik. At this place paper manufacture was started in 1875 by a joint-stock company who had bought an old flour mill situated at the river Susaaen. Here a

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large new plant was built which at the time of the merger was equipped with two paper machines.

This mill has seen great expansion in the course of the years, and it now boasts seven paper machines with a total output of about 27,000 tons per year. Gl. Maglemølle also includes a plant for the production of groundwood.

The production includes printings, wrappings, bag papers, wall papers, toilet papers, paper napkins, and several other qualities. The staff of this mill numbers altogether 700 persons.

NY Maglemolle Papirfabrik. The mill has been built on a site adjoining the canal built by the town of Næstved from Næstved to the sea. The canal and the mill were both taken into use in 1938.

The original plant comprised two machines for the manufacture of machine glazed paper, but in 1950 a third machine was added for the purpose of making woody printings and magazine papers.

The output of the mill is 26,000 tons per year, and the total number of persons employed is about 380.

Silkeborg Papirfabrik. The mill was established in 1844 by Michael Drewsen near the old Silkeborg Manor, and as a consequence a whole town sprang up in this place.

When in 1889 the mill joined the merger, it was equipped with two paper machines to which a third has now been added, the total output being about 6000 tons per year. The comparative smallness of this output is due to the fact that the Silkeborg mill is the place where the higher grade paper qualities are manufactured, as e.g., paper for official use, bond papers, ledgers, and high-class writings and printings. It may further be mentioned that at this mill handmade paper is still manufactured, e.g., for bank notes.

The staff numbers about 410 persons.

Finland

The expansion work at Jakobstads Cellulosa Ab—Pietarsaaren Selluloosa Oy's pulp mill was completed last Spring; since then the plant's new departments have been in operation. The capacity of the mill was raised to 70,000 tons of strong sulphite cellulose per annum. The main items of the enlargement work were: two new digesters of 300 cu. m. each, plus blow tanks; two new acid towers, one pressure acid cistern for the acid department; new knotters and flat screens in the screening department; the barking department was furnished with two new barking drums 6 m. by 14 m., a 10-knife chipper, and a new chip screen. Chips are now carried from the barking to the cooking department on a new belt conveyor. The new drying machine is a fan drier. The same width as the old, i.e., 3.4 m., it is made for a capacity of 120 tons per 25 hr. A new repair shop, workers' canteens, and a drawing office have been established. Also erected: a new storage and office building.

Despite a slight drop in the production statistics for the month of April, Finland's chemical pulp industry can be said to be in full production. Most of the mills have orders covering the bulk of their 1954 output and those who don't are expected to commit their open balances during the early part of the third quarter. About half of Finland's chemical pulp mills intend to run full all Summer—with the exception of a week or two vacation shutdown—which is quite different from the prolonged "down for repairs" periods of the last two years.

Finland is suffering from a low water level which threatens power cut-backs in the near future. Light rains last Fall and this Spring, plus a relatively light snowfall during the Winter, have served to reduce the water level in practically all basins to a point far below normal. Many rivers and feeder streams are being left with logs on the banks, to be floated next year. The groundwood mills have been warned that they may expect reductions in the amount of power available to them. This will undoubtedly mean a cut-back in the production of groundwood pulp for export but it is not expected that newsprint output will be affected.

Greece

Statistical data compiled by the Greek Ministry of Industry show that production of paper and paperboard in 1953 amounted to 32,865 metric tons compared to 26,568 metric tons in 1952 and 24,390 metric tons in 1939. According to estimates of the Ministries of Commerce and Industry, consumption of paper and paperboard during 1953 was 52,750 metric tons.

Greece: Imports—Pulp, Paper, and Paperboard (M. Tons)

	World	*U. S.*
Wood pulp	27,471	...
Paperboard	3,507	28
Wrapping paper	1,086	4
Newsprint	11,781	n.a.
Printing and writing	907	3
Cigarette	348	43
Cellophane	178	n.a.
Photographic paper	206	7
Paper products	1,284	119

The liberalization of Greek import trade in 1953 resulted in increased imports of paper. According to official statistics released by the Greek Ministry of Commerce imports of pulp, paper, and related products during 1953 amounted to 46,803 metric tons as compared to 35,036 metric tons during 1952. According to the same sources, 1953 exports, consisting almost exclusively of rags for the paper industry, amounted to 2356 metric tons.

Italy

The "recovery" and increasing demand for paper and cardboard products in Italy which began in the closing half of 1952 was not only sustained in 1953, but increased to such an extent that total production of 667,100 metric tons was 13.2% higher than the 589,500 tons output in 1952 and again attained a new national record. By categories the greatest increase was in the packing paper sector, 32.8% over 1952, followed by printing and writing paper, 19.1%; cardboard, 15.3%; "other types" (mostly straw paper), 6.5%; and newsprint, 3.7; only in the case of wrapping paper was production down 5.3%, 54,900 tons in 1953 vs. 58,000 in 1952.

Because statistics of paper and cardboard stocks as well as sales are considered in Italy to be trade secrets, it is difficult to arrive at close estimates of national consumption. Total availability of paper and cardboard products (i.e., domestic production plus the excess of imports over exports) during 1953 was 711,400 tons. This would indicate an availability of 106.6% of domestic production during 1953.

Per capita consumption of paper products in Italy which was approximately 11.3 kg. (24.9 lb.) in 1951, and 12.5 kg. (27.5 lb.) in 1952, jumped to about 15 kg. (33.0 lb.) in 1953. When comparison is made to the consumption figures for other Western nations, Italy has still a long way to go, but it is significant that consumption increased a good 20% in 1953 as compared to the production gain of 13.2%. In fact, the paper trade association, although not releasing actual sales data, admits an increase of 23% of sales of all products in 1953 compared to 1952.

Italian production of wood pulp in 1953 totaling 148,000 tons increased modestly by 4.1% over the 1952 output of 142,000 tons. Chemical pulp production declined to 82,000 tons from 83,000 in 1952.

Imports of Paper and Board More than Doubled in 1953

Imports of paper and cardboard during 1953 totaled 55,979 tons. This was not only the largest annual total in Italian history but also represented a 101.6% increase over 1952 imports of 27,774 tons and a 138% increase over 1951.

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Austria was the principal source of the imports, supplying 23,551 tons in 1953, followed by Sweden—16,413 tons, Finland—4163 tons, and Switzerland—2267 tons. During 1953 Austrian paper and cardboard exports to Italy almost doubled the 1952 total, Swedish exports increased about 283%, Finnish exports increased 771% and Swiss by 583%. The only significant decline by national source was in the case of the United States, with exports to Italy dropping from 2684 tons in 1952 to 996 tons in 1953. This is attributed not only to reluctance of the Italian government in granting dollar import licenses but also to the more competitive prices from European suppliers.

Paper and Board Exports Decline Sharply

Italian exports of paper products totaling 11,679 tons in 1953 were 58% less than 1952 exports of 27,790 tons, which in turn were 58% less than the 67,086 tons of 1951. Thus in two years Italian exports have fallen to a little more than one sixth of the 1951 peak and the paper industry has moved from a very favorable balance of foreign trade in 1951, to near-equality in 1952 (exports 27,780 tons vs. imports 27,779 tons), to a heavy deficit of 44,300 tons excess of imports over exports in 1953.

The export decline is attributed primarily to price cutting by Italy's European competitors, including again the allegation of dumping by Austria. Trade leaders complain that the Italian government does not afford the facilities or protection to the paper industry as are granted in competing countries, such as export premiums and reduction of taxes, and in fact while exports of paper products from Italy are still subject to obtaining export licenses, imports are completely free of restriction.

Paper Industry Prospects for 1954

The production capacity of the Italian paper industry is considered to have expanded to a total of 800,000 tons per annum at the beginning of 1954 of which about 140,000 tons remains (unchanged from the beginning of 1953) that of newsprint. The increase in capacity as in 1952 was again achieved by expanding existing plants and modernization of machinery.

The paper trade association takes a rather pessimistic attitude about prospects for the current year, pointing to declining exports and increasing imports as a continuing menace to the domestic industry. It was pointed out that during the first quarter of 1954 imports of paper and cardboard amounted to 12,890 tons against 7660 tons in the corresponding period of 1953 and a number of small firms have been forced into failure.

The shortfall of Italian production, attributed principally to low newsprint prices which diverted manufacturers to more profitable fields, forced the importation of 21,055 tons of newsprint during 1953, or well in excess of three times the 1952 imports of 6210 tons. Sweden was the leading source with 8084 tons (2174 tons in 1952), followed by Austria—6709 tons (3364 in 1952), Finland 2859 tons (250 in 1952), and Switzerland—2010 tons (none in 1952). Exports were insignificant since again in 1953 export licenses were refused by the government.

Norway

Production was at an all-time high with most pulp and paper mills producing at maximum practical capacity. The only apparent threat to continued capacity production is an imminent pulpwood shortage; domestic pulpwood production, limited in the interests of conservation, has been insufficient to cover the demands of the pulp industry, and stocks have dwindled. The industry is resorting to pulpwood imports.

Exports of pulp and paper are at a postwar high, with bleached sulphite and newsprint especially in demand. Most pulp producers have sold or reserved their entire anticipated output for the year; therefore, no marketing difficulties are expected in this branch of the industry for the rest of the year. Newsprint has also sold out for the year. Other grades of paper are being sold for more prompt delivery. All branches of the industry are enjoying reasonable profits.

Domestic consumption of pulp and paper continued to increase in the first quarter. Consumption of paper and board is now about twice the prewar consumption. Stocks remained small, having been drastically reduced in the last four months of 1953.

The industry continued its program of rationalization and modernization which, together with a modest expansion of facilities, gives promise of improved efficiency, increased production, and a better return on investment.

Impending Timber Crisis

The only apparent threat to continued full production in the pulp industry is an impending shortage of pulpwood. In 1953 the Norwegian pulp industry consumed 4.4 million cubic meters of pulpwood, only 3.46 million of which were obtained from the fruits of the 1952/1953 cutting season; the rest had to be obtained through a drastic reduction of timber stocks (saved from the abnormally large cut in the 1951/1952 cutting season), through an increased use of small-dimensioned timber and logging waste, and through imports from Finland and Sweden totaling 129,000 cu. m. during the year.

For a number of years, Norway has been obliged to limit and control domestic logging operations in order to preserve her dwindling timber resources. Thus, on April 15 of this year a normal timber cut was reported in the current season with a total of 6.4 million cubic meters, compared with 6.5 million by the same time last year. Because of the unexpectedly heavy snowfall in February and March of this year, unusual difficulty was encountered in transporting some of this timber out of the forests, and for that reason the delivery of timber to consumers may be somewhat less this year than last. Moreover, this timber will go to various industrial consumers in Norway, not only in the pulp industry, but also in the other wood-processing industries and to the lumber mills. The current demand for lumber is unusually high due to the enormous building program still going on in the country. A small amount of timber continues to be exported to Sweden in border areas. Therefore, the Norwegian pulp industry cannot expect to receive more pulpwood than it did last year from domestic sources. On the whole, the Norwegian sulphate industry enjoys an adequate supply of domestic pine; it is the sulphite industry which is suffering from a shortage of spruce. The industry estimates that it will need to import almost 1 million cubic meters of spruce alone if the present level of production is to be maintained. But the importation of pulpwood is expensive and there is some doubt in industrial circles about whether the Norwegian industry can afford sizable imports. During the first quarter of this year 111,000 cu. m. of pulpwood were imported—91% from Sweden and the rest from Finland (mostly log ends).

Paper and Board Production

The Norwegian paper and board industry finished 1953 with a total production of 505,343 metric tons of various grades, almost equalling the all-time high set in 1951. Capacity production continued in the first quarter of 1954 following increases in domestic pulp production, in domestic consumption, and in world demand for Norwegian paper and board, especially for newsprint.

Current trends indicate a moderate future increase in paper and board production through a gradual expansion of facilities. The paper industry has no present plans for a vast expansion of facilities; the less-important board industry is expected to expand proportionately more than paper. Expansion is hindered by the limited domestic production of

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* Everdur screws, bolts, nuts, washers and tie rods for wood vat and tank construction, and for most pulp and paper mill fastening requirements.

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Copper and Copper Alloy welding rods for gas and arc welding.

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Corrosion Resistance of copper and copper base alloys to specific corrodents is discussed and tabulated in Anaconda Publication B-36, "Corrosion Resistance of Copper and Copper Base Alloys." A free copy will be mailed upon request.

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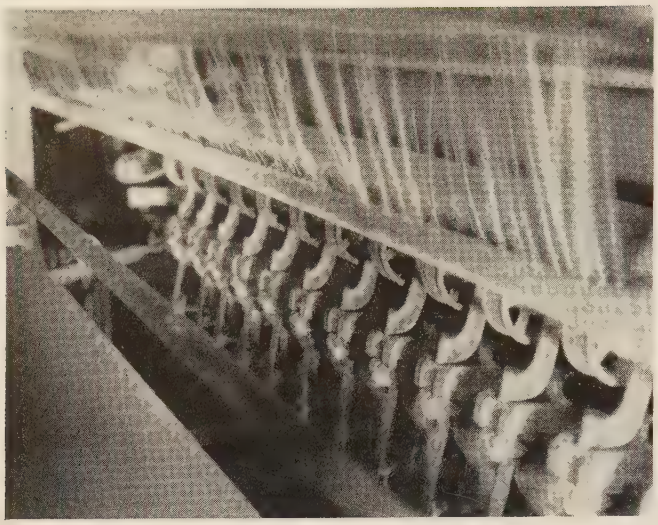

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pulp. Increased production can be brought about only at the expense of reducing the high level of pulp exports. This would, of course, have a serious effect on Norway's ability to supply traditional foreign buyers of her pulp (notably the United Kingdom) but should result in a critically needed increase in foreign exchange earnings for Norway through the exportation of finished rather than semifinished goods. The Norweign government attaches great importance to the latter goal in virtually all industries. (There is, however, no assurance that Norway would be able to market more paper abroad in substitution for exports of pulp.) Another factor behind an increase in paper and board production is the gradual rise in domestic consumption; Norwegian pulp producers are committed to supply the domestic paper and board industry with all the pulp it needs in producing for domestic consumption, and at unusually favorable prices.

Exports

The foreign demand for Norwegian pulp and paper has increased markedly since the recovery of world trade following the post-Korea slump, and Norway is currently exporting more pulp and paper than at any time since the war. But inasmuch as world prices remain well below the abnormally high levels which prevailed from the beginning of 1951 to April, 1952, Norway is realizing considerably less income from a larger volume of exports. Despite near-record production, current Norwegian exports of pulp and paper remain well below prewar exports chiefly because of increased domestic consumption of both pulp and paper since the war.

The importance of pulp and paper exports in Norwegian foreign trade can hardly be overemphasized. In 1953, as it has for many years, the pulp and paper industry ranked first among Norway's export industries with exports of pulp, paper, cardboard, and wallboard valued at 836.8 million crowns (kroner) ($119,662,400) and representing over 23% of the country's total exports by value. The industry bettered this mark in the first quarter of 1954 with exports of pulp, paper, cardboard and wallboard in January and February valued at 154.2 million crowns ($22,050,600) or more than 25% by value of Norway's total exports during the period.

Pulp Consumption

Norwegian pulp producers are committed to supply domestic converting mills with all the pulp they require to produce for domestic consumption. This is by voluntary agreement in the industry; the details of the allocations of pulp are worked out by the pulp and paper associations. Integrated organizations as well as companies specializing in the production of pulp are committed to supply nonintegrated mills. Moreover, the national price control authority requires that pulp be sold to domestic converters at prices 100–200 crowns ($14.30–$28.60) less than the export price of pulp for that portion of their production which goes to the domestic market; this regulation is designed to effect stability in the Norwegian economy.

Expansion of Facilities

In the first quarter, the 1953 annual reports of a number of leading Norwegian pulp and paper concerns were published. These reports reveal efforts by leading producers to rationalize their operations and expand their facilities.

A/S Borregaard, the leader in the Norwegian cellulose industry and a remarkably integrated organization, opened a rayon yarn spinning mill in 1953 and began modernization of its chemical pulp factories in Sarpsborg. A 4500-kw. turbine was installed and two others totaling 7000 kw. were ordered. A new bleaching mill is scheduled to begin operation this year. Two kraft paper machines were rebuilt in 1953.

A/S Union, a group of six pulp and paper mills and the

leader in newsprint production, reported investments totaling 14 million crowns (almost $2,000,000) in plant and equipment at its factories during 1953. This included a 16,000-hp. power station and modern grinding mill a Skotfoss as well as modernization of paper machines. Union is experimenting with the production of low-grade sulphite pulp from pine with a view toward constructing a new newsprint factory with a machine capable of producing 45,000 tons per year. At the end of last year Union decided to construct a mechanical pulp mill with an annual capacity of 40,000 tons at Skien in Southern Norway.

In 1953 Saugbruksforeningen at Halden, another large and well-integrated organization, opened an automatic timber cutting plant, reconstructed its chemical pulp storehouses which had been destroyed by fire, and rebuilt one paper machine. Future plans call for a new chemical pulp digester, an expansion of the caustic soda plant, and the rebuilding of another paper machine. The construction of a plant for calcifying sulphur, said to be the first in Europe, was completed early this year.

A/S Vestfos Cellulosefabrikk, a leading producer of chemical pulp and wrapping papers, is completing a 7-year $1.6 million rationalization program this year, particularly in its paper section. The investment will not result in increased cellulose production but will bring the company into the production of fine paper and board. One paper machine was rebuilt in 1953 during a slack production period.

In February of this year private capital was solicited for construction of a mechanical pulp plant to be located at Vadheim on Songnefjord in West Norway; within a few weeks minimum initial capital requirements of 1 million crowns ($143,000), had been oversubscribed. The proposed site is in an area once rich with forests but heavily cut-over around the turn of the century; there are now no pulp or paper mills in the Sognefjord area, and the project has captured the interest and imagination of the residents of the area. The scheme is based on an effort to utilize hardwoods and poor-quality conifers of the region for industrial purposes. The plant is designed for a modest production of 10,000 tons (50% wet) of mechanical pulp and will cost around 6.5 million crowns ($925,500). However, a general meeting of the investors is at present discussing the desirability of expanding the proposed plant to include cardboard and pasteboard production, at an additional cost of about 4 million crowns ($572,000) in view of the rapidly increasing demand for cardboard by packers of agricultural products.

As for the acquisition of new paper and board machines, in 1953 A/S Granfos Brug and A/S Ranheims Papirfabrikk each added a paper machine while A/S Mesna Tresliperi added a board machine. This year another board mill will be completed by the Rena Kartonfabrikk A/S.

Export Tax Suit

In mid-May of this year the Oslo City Court began hearing a suit brought by the entire pulp and paper industry against the state over the legality of taxes levied on exports of pulp and paper in 1951 and 1952. The taxes, amounting to 171 million kroner ($24,453,000) in 1951 and 87.5 million ($12,512,500) in 1952, were levied by the Ministry of Finance, under general authority of a 1947 price control act, ostensibly for the purpose of defraying costs of an extensive price control structure. The plaintiffs, 71 firms which initiated the suit in May, 1952, through the Norwegian Wood Processing Council, contend that far from being used for mere regulatory purposes, much of the proceeds of the export taxes have been used for general revenue purposes. The plaintiffs further contend that such taxes are unconstitutional inasmuch as

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they were levied by an executive agency rather than enacted as legislation by the Storting (Norwegian Parliament).

In its brief the pulp and paper industry has emphasized that it is suing only for a matter of principle, in demonstration of which it is demanding refund only of a token 5000 crowns ($715) of the 258.5 million crowns ($36,965,500) collected by the government.

Government spokesmen have pointed out that because of existing contractural arrangements, unknown to the government at the time, the pulp and paper exporters were able to pass the taxes along to foreign buyers in the form of increased prices, thereby frustrating in part the objectives of the price controls. The government contends that the Storting had legally delegated authority to the Ministry of Finance to invoke taxation as a means of enforcing measures which the government considered essential.

Several years ago in the whaling tax case, the Norwegian Supreme Court ruled against the government's employing a similar tax for purposes other than price regulation. The pulp and paper industry is banking heavily on this precedent in an effort to establish the principle it is seeking.

SWEDEN

Sales activity in the Swedish pulp market was steadily declining during April and May following the March flurry when second quarter prices were posted.

American competition was becoming a very real threat in almost all of Sweden's export markets. The volume of American dissolving pulp offered for sale in Europe is expected to soar this Summer even though some producers are switching to the production of the paper grades of chemical pulp which is also in ample supply. Swedish trade circles believe the "feelers" have not yet resulted in large sales, and that the Scandinavian pulp prices are now at a low level below which sales of American pulp to Europe would not be profitable. Although sales of Swedish dissolving and paper pulp are very satisfactory, even with regard to third and fourth quarter reservations, the expectation of prices this year is largely the result of the present American pulp and paper export drive.

The Scandinavian paper cartels are seriously concerned by the world-wide export drive of the American Kraft Paper Exporters Association. American sales offers of kraft paper and especially kraft liners have been made in Denmark and are expected soon in Sweden and Finland. In multiwall sack and bag paper, the Swedish prices are £ 1 ($2.81) to £ 2 ($5.62) (c.i.f. per long ton) above American quotations to Europe, but since they are of better quality the American competition is not serious. However, American manufacturers are said to maintain large stocks of kraft liners in London and Antwerp so that they actually quote delivered instead of c.i.f. or f.o.b. prices, and give immediate delivery. In bag paper, the American price quoted to South Africa (Port Elizabeth) is £ 15 ($42.15) to £ 18 ($50.58) below the Swedish price and as a result that lucrative market appears lost. No Swedish counter measures have yet been discussed but the resentment lies deep. Kraft paper prices will remain unchanged.

Groundwood Production May be Curtailed

The low water in Norrland's streams is causing some apprehension especially to the manufacturers of mechanical pulp. Unless rainfall increases in the North and along the Norwegian border there may occur a power shortage which would curtail groundwood production. Unlike Norway, the timber supply appears very adequate. The disastrous storms of early January blew down two years' consumption of sawlogs and indirectly increased wood waste and pulpwood in the Bergslag and Dalarna districts where wood has not been plentiful in recent years.

Unbleached Kraft Paper

Unbleached kraft paper was first made in the United States about 1906 when the paper mill at Roanoke Rapids, Va., began producing wrapping paper. The first record we have of any kraft paper production is that of 12,700 tons produced in 1909—just 45 years ago. Our present capacity for unbleached kraft paper alone is 2,750,000 tons a year at which rate of capacity we could produce the 1909 total production in 45 hours! The main growth has taken place since World War I. Recently, the industry has been doubling in size every ten years. Today, it produces at a $2^1/_2$ million ton annual rate.

There are approximately 40 companies operating 123 machines in 52 different mills. These machines vary from small low-speed specialty machines to some of the fast giants recently built in the South. Daily production per machine varies from about 25 tons a day to 250 tons a day.

Basically, kraft paper production had its initial growth in the North. Later on, techniques were discovered for using the fast-growing southern pine and western spruce and fir. Because of this, nearly all of the newer, bigger, and faster machines are located in the South and West and are integrated with pulp mills which can draw on this fast-growing pulpwood. Today, over 85% of the total unbleached kraft tonnage is produced in integrated mills in the South and West. The remaining 10 to 15% is made in converter and integrated mills located mainly in the North.

Since these southern mills are well suited to lower cost production of long run standard grades, nearly all of these standard tonnage grades are now made in the South while the Northern and Eastern mills concentrate mainly on specialties and tailor-made grades.

In the past, there was great competition between northern and southern producers. Today, however, although both call their product kraft paper and frequently use the same grade names, there is not too much direct competition between the two groups. Each has found its own niche. In some grades, the North makes a Cadillac; the South a Chevrolet. In other grades, particularly where small quantity highly specialized uses are involved, the paper can only be made practicably on the smaller, slower, more flexible northern machines. There is a place for each!

Kraft paper is made almost entirely out of long-fibered unbleached wood pulp. This gives it relatively great strength. Although there are many other specialized uses, I'll venture to say that over 90% of the tonnage goes for packaging, protection, or carrying.

The best known grade, but not the largest or most important, is wrapping. Before bags were developed, wrapping was the "big dog." Today, it represents only one eighth of the total. Throwing all types of wrapping in together, standard, butchers, and specialty, it ran about 335,000 tons last year. A lot of this is used to wrap purchases in many types of stores, but about two thirds is used by manufacturers as an industrial wrap for their products, frequently in combination with corrugated containers and other packing materials. Wrapping used to be the "big dog," but in recent years it has been the victim of bags and boxes. It is so much quicker and cheaper to stuff something into a bag or box! Automatic wrapping machines are affecting this, however.

Bags, exclusive of multiwall shipping sacks, represented a little over one third of the total kraft paper—800,000 tons in 1953. This is the biggest single group.

Shipping sacks or multiwall bags have been the pace setter in the last 15 to 20 years—tripled since 1941 to 786,000 tons of kraft paper in 1951 and not much under that today. And, this is where the main, immediate growth in kraft use is expected. The feed industry recently started to switch to paper bags. Some who are close to the situation estimate that it could bring another 300,000 tons to kraft. In general multiwall grows as chemicals grow.

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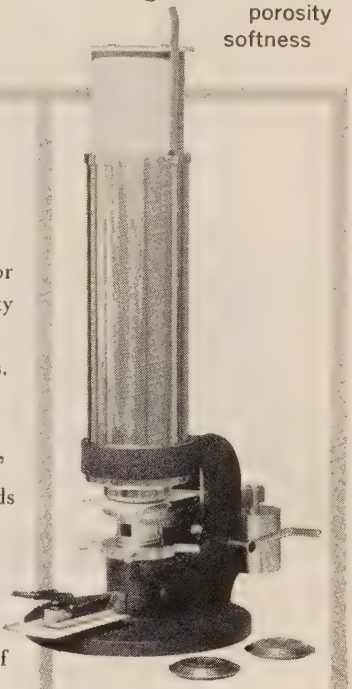

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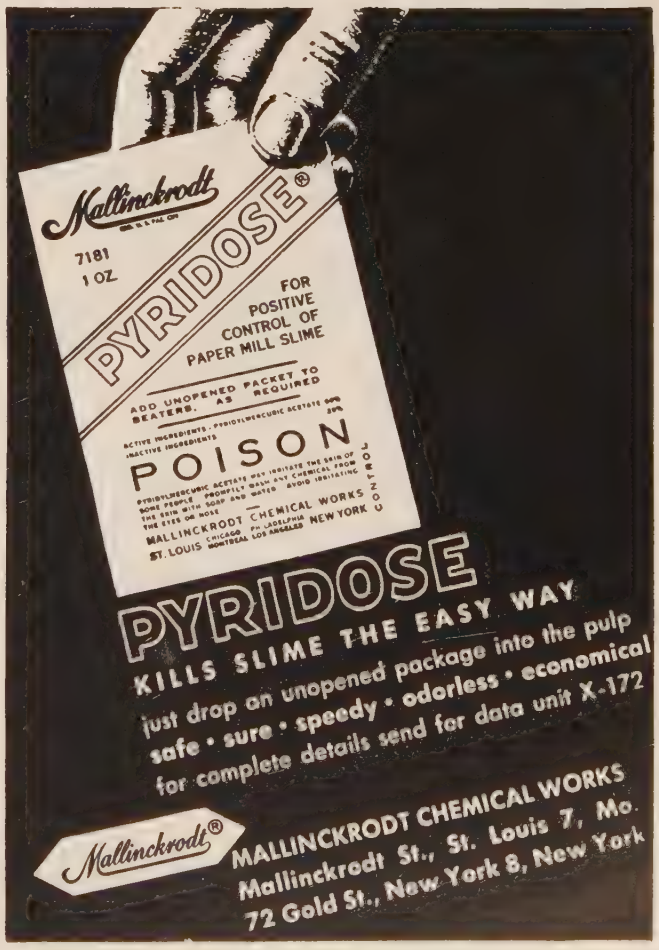
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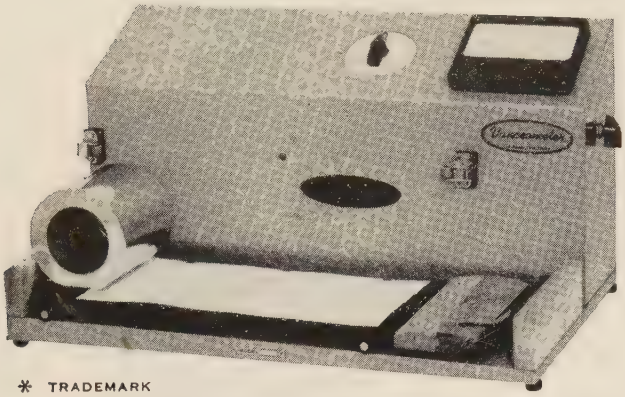

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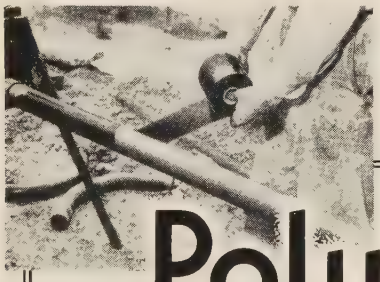

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To show you the strength of the growth pattern, cement was one of the first big users of shipping sacks. In recent years, there has been a switch by the cement industry to bulk shipment. But there has been such a growth in the chemical business generally, the sack industry took the loss of much cement business in its stride.

Other grades are: asphalt laminated or waterproof paper, enormous requirements by the Government during the war—now 133,000 tons of base stock last year; gumming, 93,000 tons; kraft envelope, 60,000 tons; saturating, waxing, twisting, window shade stock, and on down through the 40 odd grades which have standardized enough to allow the Kraft Paper Association to collect statistics on them—down to flameproof—86 tons last year. But don't laugh! Flameproof is going to surprise you. You are familiar with insulation batts made of rock wool or glass wool. A nice fireproof building material but packaged in a flammable piece of paper. All that they are waiting for is a really flameproof sheet at a reasonable price.

Nearly all kraft paper goes through some form of conversion—is made into something—a bag, a roll of tape, or an envelope. One of the outstanding developments in the kraft industry in the South in recent years has been the growth of vertical integration—where a mill converts its own paper into bags or other products, in its own converting plant. This is taking place mainly in the large tonnage standard grades. Last year 6 out of every 8 tons of bag paper was made into bags by the manufacturers of the paper. In shipping sacks the mills converted a little more than hal the tonnage. In gummed tape, in asphalt laminated paper, there are big mill converting units. Actually today there are, I believe, just three big southern mills which do no converting of kraft paper. The others vary from those converting a very small percentage in strictly limited fields to those who convert practically 100% of their paper. This is mainly a standard grade phenomenon. Most of the specialty grades are converted by independent specialty converters.

Most mills that sell kraft paper to others to convert do so directly through their own sales force rather than through merchants. However, the merchant distributors play a major and vital part in the sale of the converted products of kraft paper. Wrapping, grocers, and other stock or standard bags, tape, waterproof paper, envelopes, waxed paper, and others particularly where by nature they are standardized products that can be satisfactorily stocked, are normally sold through distributors who can buy carloads and split them into the small units normally required by the retail or industrial user. This reduces both sales and shipping costs—gives a mill much wider distribution than it can get for itself. The chain stores with their large requirements can buy carload lots and frequently do buy directly from mills.

Multiwall bags, on the other hand, are generally considered to be a made-to-order or tailor-made product with special printing, and are sold direct rather than through distributors. The users are frequently large enough to buy sizable quantities.

Outlook

In 1953, according to the Kraft Paper Association figures, the kraft mills operated at a rate of 89% of capacity for the year. For the first quarter of 1954, the rate of operation was 93.7%.

I don't see anything immediately ahead that would abruptly change this. I expect a slight tightening up or improvement, gradually building up over the balance of the year. I think this mainly because I expect general business to do about the same thing. I think the psychology in general and also in kraft paper is gradually getting better. Remember that kraft paper is used for so many things you cannot judge its weakness or strength by the weakness or strength of one particular segment. As long as shipping sacks and grocery bags continue to be used at the rate they are today we can

certainly expect our business to run along generally as well as it has been doing.

As to the long-run picture—my guess is that there will be a continuation of the growth trend but at a slightly slower rate. Some of the big growth factors are playing out but others will take their place.

The kraft paper business has come a long way in recent years in the ability of the companies to control their own destiny. Not many years ago, a number of the important mills were so poorly financed they were unable to stand a slowdown in business. They had to keep their machines running almost regardless of price. And, unfortunately, kraft paper use is not particularly increased by short-term cuts in price. Like most products, low prices help kraft capture new markets but not immediately in times of stress. Today the mills are better organized, and kraft paper is not dependent on any one use or section of our economy. It seems rather to be tied to the general over-all level of activity—which as you know has been pretty good country-wise despite some pessimism and some slumps in various sections of industry. It has been said that the kraft industry is like this: when it's good it's wonderful; when it's bad it's still pretty good!

Bleached Kraft Paper

Here we have a problem of definition. Bleached kraft pulp is used in coarse papers such as bag, wrapping, waxing, and others, and also in many printing papers, either as a blend with other pulps or as the complete furnish. How do you draw the line as to what should be called "bleached kraft paper?" I don't know!

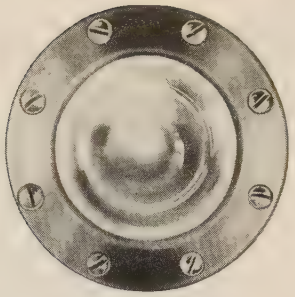
First, let's look at bleached kraft coarse papers. It is very hard to get statistics. Some are reported to the Kraft Paper Association; others are included in the tonnages covered by the Sulphite Paper Manufacturers Association but cannot be segregated from paper made of all or part sulphite pulp. Since these bleached coarse papers by their use, require strength, there has been a decided shift to the strength-giving-bleached-kraft as opposed to sulphite pulps. This shift should continue, particularly where the mills continue their progress in obtaining the other fine characteristics that have long been obtainable with sulphite papers.

The use of bleached paper in grocers' bags and shipping sacks has grown rapidly but is still very, very small relatively. The Kraft Paper Association reports about 40,000 tons of this in 1953. White bags are used mainly where package appeal is an important factor in determining which brand the housewife, or farmer, will buy. Shipping sacks for industrial materials and grocer bags in general are still made of brown kraft. I doubt that there will be any important changes here in the near future.

As to the use of bleached kraft pulp in printing papers, this growth has come about even more rapidly than in coarse papers, and I believe it will continue that way. The latest year for which we have a statistical breakdown is 1947. As far back as that, 500,000 tons or approximately one half of the total consumption of bleached kraft pulp was in the census classification—book, fine, and absorbent papers. In that year, approximately four tons of bleached kraft pulp was used in those grades for every ten tons of bleached sulphite. Remember this was back in 1947. Since then the great majority of the new domestic bleached pulp capacity has been in the sulphate grade. Bleached kraft pulp has long since proved that it can be used, wholly or in blends, in most grades of printing papers.

The use of this pulp in these grades has been almost entirely a development of northern companies, either in their northern mills, or in the case of one or two, in southern mills built for the purpose. You know what a great success the latter companies have had.

The big southern kraft mills, where they have gone in for bleaching, have put this tonnage in the coarse paper field or in the rapidly growing paper milk bottle and food or specialty



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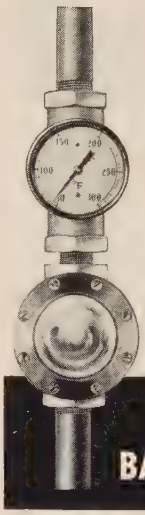

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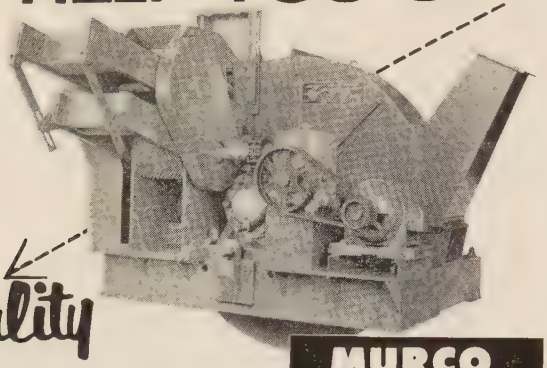

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board field. These grades have taken up the additional bleached pulp as fast as it became available. However, as the competition in these fields grows I believe that it will be a natural move for some of these southern kraft mills to look to kraft printing papers as a field for expansion and upgrading. Look at these two reasons: first, their relatively low-cost pulp and papermaking equipment should give them a good cost picture when large tonnage and long runs are possible; secondly, and perhaps even more important, as a use for the short-fibered hardwoods which grow over large areas of the South. From the standpoint of proper forest utilization, it is desirable to find additional uses of these hardwoods. These short fibers cut down too much on strength of coarse papers, but are necessary in printing papers.

My own company is engaged in such evolution—rather we are finding it a revolution. This seems to us to be a logical development that may spread.

—by J. R. W. Street, *Camp Mfg. Co.*

Tree Farms

The American Tree Farm System through which private woodlot owners are growing trees as a commercial crop has passed the 31,000,000-acre mark.

Biggest gains this year were registered in the South. Florida's Tree Farm acreage jumped from 1,447,098 acres a year ago to 2,451,333 acres. Texas maintained its national lead with 3,366,375 acres, an increase of 101,581 during the past year. Georgia jumped Tree Farm acreage from 1,031,051 to 1,316,138. Mississippi hit 1,178,348 acres, up 70,419 in 12 months. Louisiana gained over 100,000 acres for a new total of 1,578,774.

Forest Service Bulletins

The following bulletins have been published by the Northeastern Forest Experiment Station of the Dept. of Agriculture Forest Service, Upper Darby, Pa.; Station Paper No. 67, Reproducing Pine Stands on the Eastern Shore of Maryland; Station Paper No. 68, Growth Response in Allegheny Hardwood Forests After Diameter-Limit Pulpwood Cuttings; Station Paper No. 69, Use of Plant Indicators as an Index to Site Quality.

Automatic Threading System for Calender Stacks

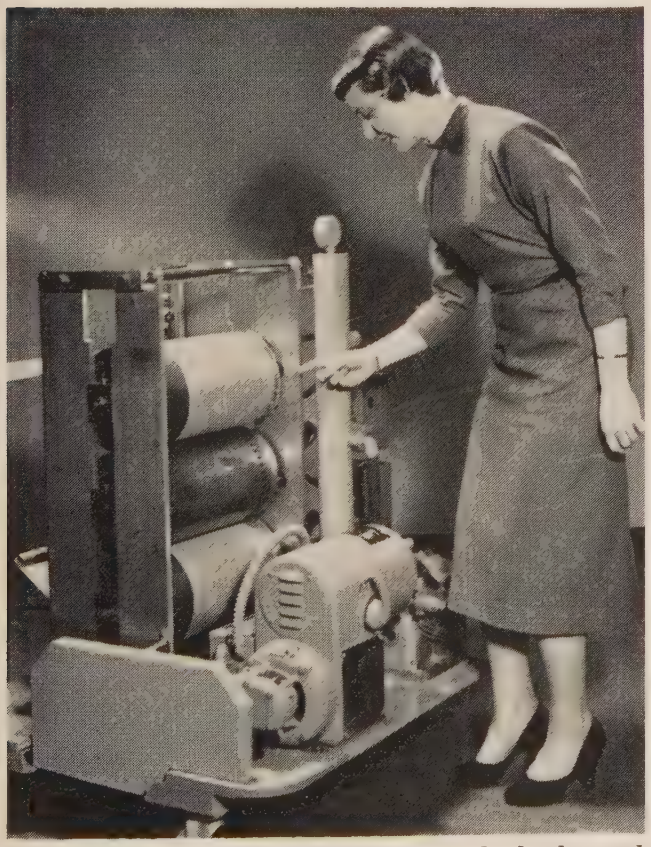
The system for automatically threading paper through a calender stack described below was developed by the Engineering and Loss Control Division of the Travelers Insurance Co. Basically, there are three main functional parts to the system. The first is the vacuum system which is applied through valve plate groove of approximately 180°, radially, to successively opposite halves of successive rolls. Since the valve plate is stationary and is held by light spring pressure against one end of each roll, a standing sector of vacuum exists at the slots in the rolls which is independent of the speed of the rolls, themselves. The exact size of the valve plates is unimportant. They can be made in two parts or as a C ring for easy installation. The slots shown cut in the rolls need not be so located but can be incorporated in an adapter piece which is bolted or welded to the ends of existing rolls without necessitating machining grooves in the rolls. Exact alignment between this added piece and the surface of the roll is also necessary.

The adapter piece can be somewhat smaller in diameter than the rolls and still operate satisfactorily. The order of vacuum required is about 1 to 2 p.s.i. for ordinary weight papers. The vacuum can normally be decreased as the diameter of the roll increases, or as the weight of the paper decreases. A pressure distribution system whereby a slight positive pressure is applied to the slots immediately after the paper leaves the nip is incorporated. This positive pressure serves two purposes: (1) it aids in breaking the vacuum and freeing the paper from the upper roll and (2) it continually

cleans the orifice at the bottom of each slot so that the lint and dirt will not collect there.

The second major part of the system is the vacuum sequencing arrangement. A curved leaf spring arrangement is mounted on an insulating pad to the left of the roll 1 and to the right of roll 2 near the inrunning nip. There is an electrical spring contact (6 v.), and controls, through a relay, a solenoid valve on the vacuum supply to the roll next below each such spring. As the paper progresses around roll 1 it opens the contact on roll 2 which, through a relay, opens the solenoid valve and applies vacuum to roll 3. This operation is independent of the speed of the paper as it is controlled by the paper itself as it progresses downward through the stack. Since the paper is covering the slots of roll 1 by the time vacuum is applied to roll 2, only one set of vacuum grooves is open to the atmosphere at any given moment. Because this sequencing system and the checking effect of the orifice at the base of each groove restricts the total amount of air entering the vacuum system, it is possible to maintain sufficient vacuum throughout the threading cycle with a relatively small vacuum pump. Since the capacity required is virtually determined by the vacuum requirements of the largest roll in the system, rather than by the sum of the rolls, the alternative to this sequence system would be a very large vacuum pump or a small vacuum pump with a very large receiver each of which is not as economical as the automatic, electrically controlled system here described.

The third major functional part of the system, which proved to be the most crucial step in the development of a successful threading system, is the stripper. This is nothing but a flat strip of polished steel which effectively makes certain that the paper is separated from the roll above and transferred to the roll below. The valve plate is slightly smaller in diameter than the roll. This was done purposely to allow space for the stripper to reach through beyond the nip of the rolls. Since the paper progresses around the roll at a slightly larger radius than that of the leading edge of the stripper, it does not con-



Threading arrangement on an experimental calender stack at the Travelers Insurance Co. where it was developed

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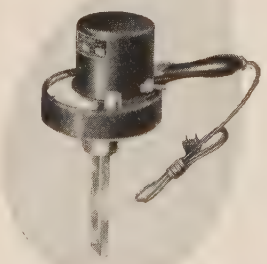

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Assembly of threading system showing adapter piece to the left, the stripper just below, and the grooved end of the roll at right

tact this leading edge but rides beneath it. As the paper passes through the nip, it is forced downward by contact with the flat undersurface of the stripper without any scraping action whatever, so that there is no chance of build-up or piling-up of the paper at that point; and it is transferred effectively to a point on the lower rolls where the vacuum slots may easily take hold of it. All this, of course, is at very high speed and very smoothly. The stripper is not in line with the rotating rolls, but rather rests against fixed parts only. As a matter of fact, the only moving part in the system (on the calender itself) is the wide, flat contact surface between the valve plate and the rotating roll. Since the valve plates are made of bronze and the grooves can be cut to any desired depth, an almost unlimited life span for the valve plate without maintenance can be predicted, proving a small amount of vaseline or similar lubricant is utilized as a seal.

The whole system is designed so that it can be adapted to new or existing machines in the space *at one end only* between the end of the rolls and the journals. Usually, this distance is at least 6 in. on the average stack calender, but only about 3 in. is required for installation of this system. The bottom roll is not altered in any way. The paper in the photograph is fed over the top of the top roll merely from choice. It is, however, possible to feed the paper into the stack at any point between any pair of rolls simply by extending the vacuum sector beyond top dead center toward the inrunning side some reasonable distance. It is contemplated that in actual operation, valve plates would be equipped with a groove of this type separated slightly from the main vacuum groove. The vacuum to this "lead-in" groove would be controlled by a hand valve so that the machine operator can determine at will the point at which he wished to insert the leading edge. Naturally, some sort of barrier protection, could be installed where necessary as it would be unnecessary for the operator to closely approach the nip with his hand for feeding purposes. Of course, it should be understood that the paper is moved slightly sideways during the feeding cycle, as is now done in most cases when hand threading. Naturally, the paper aligns itself to its running position automatically immediately thereafter, just as normally occurs after the hand-threading process.

When a break occurs and it is desired to rethread, one switch controlling the vacuum pump and sequencing system would be thrown on, either manually or by some interruption device on the web itself. The leading edge of the paper would be prepared by tearing either approximately straight across or on a diagonal as at present, and the tongue of the paper applied at the appropriate point. It is expected that this would be done by hand although it is within the realm of possibility that it could be done automatically by an auxiliary conveyor system of some appropriate design. In most cases the calender could continue to operate at speed during this threading cycle. As soon as the paper immerges at the bottom of the stack, the vacuum and sequencing switch would be shut off manually or automatically and the mill would be back in business. The feeding system equipment would simply lie idle ready for immediate use by the flipping of a switch whenever another break should occur.

Mississippi Forestry School

Establishment of a four-year professional forestry school at Mississippi State College has been approved by the Board of Trustees, and will begin in September.

Southern Pulpwood

The table which follows was taken from a report of the Southern Forest Experiment Station of the U. S. Dept. of Agriculture. The report shows an increase in the use of hardwoods (exclusive of dead chestnut), 1,918,000 cords being used in 1953. Pulpwood from wood residues totaled 76,000 cords from veneer cores, cull crossties, pole and piling ends, and sawmill slabs and edgings.

Pulpwood Production of Southern States

(Thousand cords)

State	*No. of mills*	*Mill capacity in tons of pulp per day*	*Pulpwood produced*			*Counties with highest production*
			1951	*1952*	*1953*	
Ala.	7	2,169	1,406	1,609	1,765	Baldwin, Mobile, Washington
Ark.	2	975	614	620	781	Union, Clark, Grant
Fla.	9	4,638	1,490	1,583	1,675	Baker, Marion, Nassau
Ga.	7	4,140	2,370	2,513	2,879	Clinch, Brantley, Charlton
La.	8	4,760	1,111	1,235	1,376	Winn, Union, Livingston
Miss.	6	2,895	1,793	1,865	1,923	Copiah, Clarke, Jasper
N. C.	5	2,380	1,305	1,332	1,529	Bladen, Buncombe, Halifax
Okla.	0	. . .	45	35	41	Pushmataha
S.C.	3	2,850	1,276	1,276	1,446	Fairfield, Georgetown, Berkeley
Tenn.	4	403	192	268	234	McMinn, Roane, Scott
Tex.	2	1,000	1,158	1,160	1,211	Montgomery, Houston, Nacogdoches
Va.	8	2,460	1,326	1,069	1,267	Amherst, Bedford, Buckingham
Total	61	28,670	14,061	14,565	16,127	

From the beginning of our operations, we have been mindful of the need for sound forestry and conservation practices so that there will never be a shortage of pine pulpwood—our principal raw material.

While we purchase great quantities of pulpwood almost entirely from privately owned timberlands, we have also built and developed a forestry and conservation organization in keeping with the size of our operation.

In our Woodlands Division we have 58 graduate foresters charged with the responsibility of scientifically managing our timberlands and offering forestry aid to private timberland owners throughout the territory.

I would like to tell you about one facet of the over-all development of our conservation program. In 1952, in cooperation with the State Department of Education, we began the establishment of School Forest, to augment the teaching of forestry by the Vocational Agriculture Department. These school forests are 10 acres in size, and our company has made the land available where we own a suitable site in proximity to the school and where this is not the case we have assisted in acquiring from other owners the necessary acreage.

The reason for this program is to teach forestry to the boys belonging to the Future Farmers of America, recognizing that many of these boys will become timberland owners in the years to come.

A complete schedule of forestry activities is furnished each vocational agriculture teacher, as an aid in teaching proper forestry, and our own conservation foresters assist by classroom instruction and field demonstrations.

In the short time since 1952, this program has grown to 50 established forests. By means of this program, the teaching of proper forestry and conservation, and the sound use of our natural resources, is reaching hundreds of Georgia boys.

This project is only a part of a well-rounded conservation program, which includes forest management, advice to landowners, the donation of 4 to 5 million pine seedlings to landowners annually, summer forestry camps, and yearly awards of scholarships and fellowships to 11 boys for the study of forestry at various colleges and universities.

A more recent phase of our woodlands activities, still aimed at helping assure a perpetual supply of wood, is our forest research program. We have set up a Forest Research Department which devotes full time to scientific forest research and cooperates closely with other forestry research activities over the entire South.

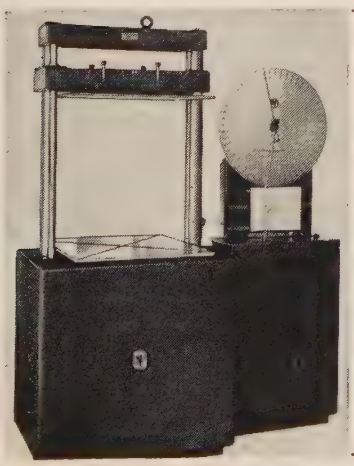
There is much still to be learned about growing quality trees, and we hope to contribute to the attainment of this knowledge. Only recently have the principles of genetics been applied to trees, although these same principles have been used by agriculturists for many years. We contribute financially to forest genetics work being conducted in Texas and in Florida, and work closely with the U. S. Forest Service in this field. This is a very long-range program but we are already applying the knowledge gained by research in our tree planting program, hoping thereby to obtain a growth rate better than the average.

This year's winners of Union Bag & Paper Corp.'s 4-year $4000 college scholarships go over their records with J. R. Lientz, manager of Union Bag's Pulp and Paper Division and chairman of the company's scholarship committee. Left to right are William F. Perkins, Robert C. Ranew, Mr. Lientz, Earl W. Heidt, Jr., Harry F. Yarbrough, and John C. Summers, Jr.

The great interest that has been created in forestry in our State has already been translated into concrete, vital results. Governor Talmadge, who has been so instrumental in the establishment of state-wide fire protection, has stated that the forest industries contribute $600,000,000 annually to the State's economy. In 1952, the U. S. Forest Service completed a re-survey of timber resources in Georgia. This is the first re-survey since 1936. In that time there has been a tremendous increase in the amount of forest products used in Georgia, but despite this large increase in consumption, our forests, on a state-wide basis, are producing pine faster than it is being used. This favorable balance is not true over the entire State. Speaking generally, the upper two thirds of the State is losing ground in pine production, but the lower portion is more than offsetting the loss—thus, giving the State an over-all favorable balance.

This favorable balance can only be explained as the result of better forestry practices, including protection from fire and the planting of thousands of idle acres. The Federal Government, the State, private industry, and private landowners have all had a part in attaining this encouraging result.

The use of forest products, however, is continuing to grow, and a great deal of work in our forests remains to be done. The U. S. Forest Service survey points out that the annual growth of the forests of Georgia could be increased



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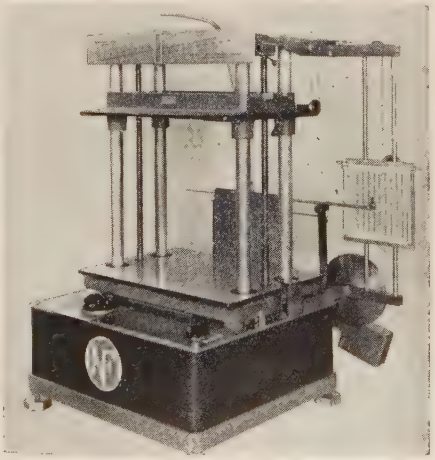


by 50%, mainly by securing better stocking of trees in the forestlands of our State. We must conclude that even though the growth-versus-use relationship is slightly favorable, we are not yet growing forest products at a rate that even approaches the capacity of the Good Earth of the State of Georgia. Therefore, we will strive to do an even better job on the lands that we own and will continue to pass on to other landowners knowledge which we gain by research and experience.

—by T. T. Dunn, vice-president, Union Bag & Paper Corp.

Fort Frances

On May 18 a new era began in pulp production at Fort Frances, Ont., mill of the Minnesota & Ontario Paper Co. With almost no disruption in normal proceedings, switches were thrown and the huge machines in the spanking new grinder room whirred smoothly into life. The first ton of pulp was soon flowing through the long pipe line on its way to the screen room and paper machines.

This was the climax of a building project begun in June, 1952, and originally scheduled to be completed in 1953. However, difficulty in getting delivery of some of the materials for the interior of the building extended the completion date into this year.

The 85 by 274-ft., three-story building near the pulpwood storage yard, is a wholly modern building, with its maroon, corrugated metal, windowless exterior. It is sheathed with a sandwich type siding called Gallbestos. This is especially designed for buildings in which a relatively high humidity may be encountered.

The interior of the building presents a revolution in Fort Frances pulp manufacturing facilities and methods. Gone are the wet wood ponds and the hand-fed, steam and stock spitting pocket grinders. Their place has been taken by modern magazine grinders, fed through hoppers from the floor above. The variable temperatures, and steam-filled atmosphere of the old grinder rooms have given way to air-conditioned comfort. Drabness has been replaced by colorfully painted walls, ceiling, and machinery.

Described as one of the most modern grinder rooms in the industry, pulp making equipment consists of 13 Waterous super hydraulic magazine grinders, using 4-ft. wood. Twelve of the grinders will produce pulp for paper and the 13th will grind Insulite stock. Provision has been made for the addition of a 14th grinder should the need arise. The 13 grinders replace 43 outmoded pocket grinders, now occupying two buildings in the mill area.

Full operation of the new grinder room will not be effected immediately. This will be brought about in stages, as experience is gained, and as more power becomes available through conversion of the water wheels in the present no. 1 grinder room to electric power generators. Transfer of all groundwood production to the new grinder room is expected to be completed by the end of this year.

Each of the 12 paper stock grinders will have a production capacity of 30 tons of specialty pulp, or over 35 tons of newsprint pulp, a day. The Insulite grinder has a capacity of 100 tons. The 13 grinders will produce 25 tons more paper pulp and 50 tons more Insulite stock than the 43 old-type grinders have been capable of making.

The grinder room building has three levels: basement, operating floor and charging floor and a penthouse on the roof, running the length of the building. Wood enters the building on a rubber belt conveyor in this penthouse. Men stationed along the conveyor sort the wood into bins on the charging floor below. Storage space on this floor will handle about 450 cords. The grinders are loaded through openings in the concrete floor, below which rectangular magazines extend down to the grinders.

Stock from the grinders is fed to bull screens at the north end of the building by gravity flow, through stainless steel stock troughs. The bull screens are the rotary type. All bull screen tanks and grinder stock pits are tile lined.

Major stock and white water lines are of transite pipe with steel couplings. Piping is confined to the basement level, and is connected to the grinders through inserts in the concrete floor.

Six 5500-hp. electric motors drive the 12 paper grinders, which are placed in two lines of six. A 3500-hp. motor drives the Insulite stone. Grinder stones are 64 in. in diameter, with 54-in. faces.

The grinder room is heated and ventilated through a Ross Engineering system. Hot vapors from stock flumes and magazines are carried off and discharged directly outside. In the Winter some of these vapors will be recovered for heating the building.

Heating and ventilating equipment consists of two fresh air supply units, two motor cooling units, one stock channel vapor exhaust unit, seven grinder magazine units, seven motor cooling exhaust units, and one locker room exhaust fan.

The grinder room is equipped with modern locker room, washroom, and lunchroom facilities. Painting of the interior of the building has been especially planned for safe and efficient operation.

Completed during the summer of 1952, and supplying the old grinder rooms since, the new woodroom at Fort Frances forms a companion facility to the new grinder room put into production in May. As well as being completely modern in all respects, it also provides the barking capacity necessary to provide wood for the increased pulpmaking now possible.

The woodroom replaced facilities which had been in operation since the mill was constructed in 1914.

The barking facilities are housed in a 73 by 164-ft. steel and brick building alongside the new grinder room. Four 12 by 45-ft. drum barkers remove the bark from the wood. The old woodroom had six 10 by 30-ft. barkers. Power for the barkers comes from individual 150-hp. motors. The woodroom can bark 25 cords of wood per hour. Room is available for a fifth barking drum, when it becomes necessary.

Wood leaves the barkers on a wide rubber belt conveyor and goes to the grinder room by means of a covered incline conveyor, also a rubber belt type.

Pulpwood, 4 or 8 ft. long, comes into the woodroom from two sources. One is an overhead conveyor, connecting the building with the river. A long jackladder stretches out into the river storage area, to lift the wood from the water. A second conveyor handles pulpwood from railway cars and trucks. This conveyor stretches approximately 400 ft. out from the building along a railroad spur. Wood from the storage yard is loaded onto railway flat cars and is then unloaded onto this conveyor. Trucks can also unload directly onto it.

Working conditions in the woodroom are greatly improved over those in the old building. Ample light is provided by 200 fluorescent units. A Ross Engineering heating and ventilating system provides air-conditioned comfort. Lunch, locker, and washroom facilities are provided on the ground floor, under the slasher area, and are finished in smooth tile.

Crown Zellerbach

The following items are taken from the annual report of the Crown Zellerbach Corp. for the year ended April 30, 1954.

Sales Use. Net sales for the year totaled $297,959,000, compared with $252,765,000 for the prior year, an increase of about 18%. Excluding $33,713,000 for sales of new subsidiaries acquired during the year, the increase is about 5% compared with the prior year.

Net income for the year was $26,828,000, an increase of 23% over net earnings of $21,890,000 for the previous year. After providing for dividends on the preferred stock, earnings on the common stock amounted to $3.65 a share based on the average number of shares outstanding during the year in comparison with $3.52 reported last year.

Dividends. Dividends of $1.85 a share were paid on the

common stock during the fiscal year. This year five quarterly dividends of $1.05 a share were declared on the preferred stock. Four of these dividends were paid during the year. The fifth was declared in April 1954 but not paid until June 1, 1954.

Total dividends paid to holders of our common and preferred shares during the year amounted to $14,166,000, representing a 53% distribution of net earnings for the year, compared with a 46% distribution in the preceding year.

Production. Production of paper and paperboard for the year totaled 1,058,809 tons, an increase of 164,425 tons, or 18%, over the output for the prior year. Of this increased production, 122,254 tons were contributed by St. Helens and Elk Falls since dates of acquisition. Production by major grades for the two years was as follows:

	Year ended April 30, 1954		1953	
	Tons	%	Tons	%
Newsprint	360,432	34.1	285,201	31.9
Other printing papers	116,898	11.0	110,182	12.3
	477,330	45.1	395,383	44.2
Wrapping papers	374,069	35.3	324,589	36.3
Tissue and sanitary papers	128,053	12.1	115,976	13.0
Paperboard	79,357	7.5	58,436	6.5
	1,058,809	100.0	894,384	100.0

Properties. During the year, expenditures for operating facilities including timberland and forest road extensions, amounted to $17,800,000.

A tract of 56 acres on the San Joaquin River at East Antioch, Calif., was purchased as the site for future construction of a paper mill.

A large addition to the Los Angeles converting plant was completed. This expanded plant provides adequate facilities for converting and warehousing paper products to supply the rapidly growing markets of Southern California and adjacent areas. The new unit and site were sold to, and leased back for a long term from, an insurance company. Following removal of operations to the new location, the buildings and site of the former Los Angeles converting plant were sold.

Other projects and installations completed at our mills include:

Camas, Wash.: Speed-up of two tissue machines for increased capacity and addition of coating equipment on a third.
Lebanon, Ore.: Facilities for producing Orzan, a commercial by-product of waste sulphite liquor.
Port Angeles, Wash.: High pressure boiler.
Ocean Falls, B. C. (Crown Zellerbach Canada Ltd.): Chemical recovery unit and reconstruction of a newsprint machine to produce a newspaper magazine grade.

St. Helens is engaged in a major expansion and improvement program which will involve the expenditure of approximately $11,000,000 during the year ending April 30, 1955. This program provides for additional pulp capacity, increased output for an existing paper machine, and the purchase and installation of a new high-speed tissue machine.

In British Columbia, Canadian Western plans to modernize and expand its plywood plant, and Elk Falls is making engineering studies with regard to additional production facilities at its mill.

Timberlands. Increasing utilization of wood wastes and harvesting of farmer wood lots is contributing to the conservation of our forest resources. Today we are purchasing about 20% of the wood requirements of our six mills in Washington and Oregon in the form of chips produced in plywood plants and sawmills from waste materials. Another 5% of these requirements is being purchased in the form of pulpwood from local farmers. The remainder comes from logs purchased from others and logs produced on corporation tree farms.

We have reforested over 31,000 acres of logged-over land in western Oregon and Washington since the end of World War II. During the past Winter alone, one and one-half million seedling trees were hand planted on 3035 acres and 268 acres were seeded by helicopter. For several years we have distributed thousands of seedlings to owners of woodland lots and provided a cash market for their pulpwood crops.

To support our Canadian operations, we own in fee, or control under various forms of tenure, approximately 920,000 acres of timberlands in British Columbia.

In Washington and Oregon we own about 635,000 acres of forest land and long term cutting rights on certain other tracts. These forests comprise a good balance of virgin old growth stands, large young timber, immature timber, and recently planted seedlings.

Research. To implement our growing research program, a new laboratory is being constructed at Camas, Wash. This laboratory will be located adjacent to the development laboratory completed in 1952 and will provide effective working area sufficient to approximately double the size of our present research staff. The new laboratory will house facilities devoted to pulp, paper, and by-product utilization projects. The building will also include the administrative office, scientific library, and an auditorium.

Fibreboard Products

The following items are taken from the annual report of Fibreboard Products, Inc., for the year ended April 30, 1954.

Financial. In our last annual report, we expressed the feeling that business should remain at reasonably high levels during the remainder of 1953. Actually, incoming orders declined around the end of the second quarter of our fiscal year. This situation continued until the last quarter when an improvement occurred which has been maintained up to the present time. Total sales for the year showed a small increase and were $91,462,000 as compared to $88,441,000 for the previous year, while profits after federal taxes were $5,539,000 as compared to $5,135,000. During the year we were able to correct some of the inequities which had crept into the price structure throughout the period of price controls. As these small adjustments in prices, however, were not sufficient to offset further increases in costs including those of certain important raw materials, transportation costs, and increased wages, the slightly higher margin of net profit was entirely due to a reduction in excess profits tax caused by the elimination of that tax effective Jan. 1, 1954. At the close of the year our liability for federal taxes was again completely funded and there was a slight increase in working capital. Other than an increase of $3,449,000 in the earned surplus account and a reduction of $1,400,000 in long term debt there were no material changes in the balance sheet of the company.

Expenditures on capital account, which amounted to $4,114,000, included the cost of a recovery boiler, a new corrugator, a new wastepaper plant, increased capacity at one of our folding carton plants, and additional timberlands. Plans for the coming year contemplate substantial additions and improvements.

Research and Development. As the general competitive situation increases in intensity, the role of modern science and technology becomes increasingly significant in maintaining and improving our ability to properly serve the requirements of our customers. Recent years have seen a healthy growth in the number of our technically trained people. Their activities may be recognized as we note the important technical contributions to the company's program which are coming from the Central Engineering Division, Research and Development Division, Mechanical Development Department, the Package Design Section of the Sales Promotion Department, and the plant laboratories of the Production Department.

New and improved cartons and containers are meeting

more severe conditions of service than ever before, but progress in packaging needs will always require a continuous improvement in the production of paperboard containers to meet the challenge of each new day.

Moisture vapor barriers, grease-resistant cartons, improved automatic machine feeding, greater stiffness under wet conditions, and close manufacturing tolerances for cartons to meet the requirements of modern high-speed automatic packaging lines, are some of the developments geared to the increasing requirements of our customers. Our Mechanical Development Department, concentrating on the design of new automatic machines for major fields such as frozen food packaging, has made several new machines available, and its staff is very active in their efforts to produce further innovations. Satisfactory shipping cases for citrus fruits, and for fresh vegetables, were produced, and were among the outstanding development during the year under review. It is particularly noteworthy that more than half of the lettuce now being shipped from the Pacific States is shipped in corrugated shipping cases.

Fibreboard Products Foundation. During the past year the company made a gift of $450,000 to the Fibreboard Products Foundation, a nonprofit organization devoted exclusively to the granting from its funds of contributions for educational, scientific, and charitable purposes. The directors of the foundation are also directors of the company. With the initial grant operating as a reserve, a reasonable continuity in giving should be achieved. In this way each dollar contributed by the company should accomplish the maximum purpose for which it was given, since in years when profits are low it is probable that needs of those organizations which receive gifts from the Foundation will be correspondingly high.

Fibreboard's technical program is leading the way to better packaging to meet our customers' needs. It is the result of careful management planning to make certain that our products are as far advanced as the present state of knowledge will permit. This open-minded attitude toward progressive change is extended into many areas of the company's activities.

A continuous program of modernization and improvement is taking place within all manufacturing units. New equipment is being installed to permit faster operations under more precise conditions of control. Fibreboard has good reason to be proud of some of the "firsts" which it has achieved. The San Joaquin Division includes a number of features such as continuous measurement of sheet weight by a beta-ray gage, direct turbine drive of the huge whole-log chipper, and unique installations of dust collection equipment. Each of these represents a pioneering achievement in the paperboard industry.

Our leadership in printing of attractive packages is maintained not only by the skill of our personnel, but by the installation of the most modern types of printing presses. Recent additions include rotary four- and five-color high-speed presses for the production of folding cartons. The five-color press now operating at our Stockton Division is the most advanced of its type, and the only such press on the Pacific Coast. The present trend toward the use of high-speed web-fed presses is part of our picture, with operations of this type now at two of the divisions.

The plant laboratories and plant engineering groups, closely allied to the production operations, are working constantly on process and product improvements. Because experience gained at one plant can often be of value at other plants conducting similar operations, provision has been made for frequent exchange of technical information. Fresh viewpoints and new approaches are stimulated by a healthy policy of promotional transfers of key technical personnel.

Engineering and package design each have a major part in the Fiberboard technical program. With substantial amounts of annual expenditures for new equipment and additional facilities, sound engineering is essential to achieve the maximum efficiency in design, construction and subsequent operation.

The Central Engineering Division includes a wide variety of talent and experience in this professional field. Its functions include the design, specification, construction supervision, and start-up responsibilities for new plant facilities. The staff includes structural, hydraulic, mechanical, and electrical engineers, in order to handle the complex problems associated with major projects.

Engineering studies and cost estimation of proposals for new installations are also an important part of the Central Engineering Division's activities. These require close liaison with management planning and effective contact with the plants so that future needs may be clearly defined and adequately planned.

High-speed automatic machinery for setting up, filling, and closing folding cartons in our customers' plants has become an important feature of modern packaging lines. The Mechanical Development Department is concentrating heavily in this field, and has produced several types of automatic machines that are distinct improvements in speed, positive action, and simplicity of design. Several projects which are now in the early stages hold bright promise for the future.

Design of containers and folding cartons to meet specific situations requires imagination, skill, and detailed knowledge of the customer's requirements. The Packaging Design Section of our Sales Promotion Department is composed of a number of our most experienced and effective packaging specialists. Here board properties, manufacturing methods, and printing possibilities are combined to create new designs that fully utilize the improved materials and techniques made possible by Fibreboard's technical program of research, development, and engineering.

Deerfield

The following personnel changes have been made by the Deerfield Glassine Co., Monroe Bridge, Mass.: W. A. Wylde, associated with Deerfield since 1934 and vice-president of the company since 1948, has been named executive vice-president and a director of the company. William K. Prutzman, since 1944 assistant treasurer of Deerfield, has been made treasurer. Mr. Prutzman is also treasurer of Canadian Glassine Co. Charles W. Cassell, formerly chief engineer of the Everett Pulp & Paper Co. of Everett, Wash., has joined Deerfield Glassine Co. as assistant to the president. R. L. Cain, formerly sales manager of Westfield River Paper Co., has joined Deerfield as a salesman on special assignments. Harold L. Field of Mechanicville, N. Y., has joined Deerfield as chief chemist. Mr. Field was formerly research director of the mill of the West Virginia Pulp & Paper Co. at Mechanicville, N. Y.

Bowaters

The new newsprint and kraft pulp mill of Bowaters Southern Paper Corp. at Calhoun, Tenn., delivered its first newsprint manufactured from southern pine to customers in the Calhoun area on July 20, 1954.

The new mill has an initial capacity of 130,000 tons of newsprint and 55,000 tons of kraft pulp a year. It is the third and largest newsprint mill to be built in the South, and the first to be financed by a newsprint company entirely from its own resources.

A pioneer mill at Lufkin, Tex., built in 1937, and the Coosa River mill at Coosa Pines, Ala., which began operations in 1950, were financed for the most part by newspaper publishers of the South. In both instances the publishers had in mind the encouragement of the newsprint industry to build such plants of their own in the South, and Bowaters represents the first of these developments.

In support of the Tennessee facility, more than 100 South-

ern newspapers, many of which formerly were supplied from Bowaters' huge newsprint mill at Corner Brook, Nfld., contracted to purchase its entire output of newsprint for the next 15 years.

Bowaters Southern is wholly owned by the Bowaters Paper Corp., Ltd., of London, one of the world's leading producers of newsprint. Much of the kraft pulp produced in the Tennessee mill will be shipped to the organization's mills in England.

The major factor for placing the mill in the South was the availability of the vast pine forests of the region. Southern pine matures to pulpwood size in 25 to 30 years, compared with the 70 to 80 years needed for the growth of northern trees traditionally used in newsprint manufacturing.

The Tennessee plant, representing an investment of $60,000,000, is located on an 1800-acre tract on the banks of the Howassee River. More than 150 concerns from all over the United States were engaged in the two-year construction job.

The plant is located favorably in regard to rail, highway, and inland water transportation. Truck, rail, and barge bring the mill its daily supply of some 900 cords of pulpwood.

Underwater Storage. An outstanding feature of the facility is its huge wood-storage pond, believed to be the first large underwater storage installation in the world. The bowl-shaped pond, 500 ft. across at the top and 380 ft. at the bottom, holds approximately 30,000 cords of pulpwood, enough to keep the mill running about 6 weeks.

This storage method is designed to eliminate wood deterioration, a vexing problem in southern pine mill operations where wood normally is stored on the ground. It also permits Bowaters to accept wood at almost any time from farmers and landowners in the area, thereby providing a year-round market. The company eventually will have some 200,000 acres of forest in Tennessee, North Carolina, Alabama, and Georgia. A program of planting pine seedlings on company property was started several years ago, and by the end of this year close to 10,000,000 seedlings will have been set out.

Power, Water Plants Built. The Tennessee plant will use about 37,000 kw. of electricity a year, about 55% of it to be generated by the mill's own power plant and the remainder to be purchased from the Tennessee Valley Authority.

A pumping station about two miles upstream sends 25,000,000 gallons of water every 24 hours to a filtration plant on a hill behind the plant.

The mill's paper machines are capable of turning out a sheet of newsprint nearly 20 ft. wide at a rate of 2000 ft. a minute.

Nepco

Start of a $6^1/_2$ million-dollar 6-year construction program that eventually will reduce sulphite discharge to the Wisconsin River to less than one fourth of the former level was announced recently by Nekoosa-Edwards Paper Co. This program has been approved by the State Committee on Water Pollution as accomplishing satisfactory stream improvement.

The project will proceed a step at a time, with each step bringing a substantial decrease in the volume of spent sulphite liquor discarded into the river. It is being spread over a 6-year period to permit efficient planning, engineering, and erection and to make the cost less of a financial burden.

Over-all goal of the program is to reduce stream pollution by transferring a greater share of the company's total pulp production from the sulphite process to the sulphate, or kraft, process in which pollution is easier to control. As a start the company has earmarked $\$1^1/_2$ million for purchase of equipment which requires the greatest delivery time, a new furnace to burn kraft liquor or chemical recovery. Installation of this furnace is scheduled for some time next year, and its start-up for early 1956.

When the new furnace begins operating, the company will add new kraft pulping capacity of 50 tons per day, and will boost this to 100 tons in 1959. By that time the company will be able to reduce its sulphite output to 65 tons per day from the present figure of 135 tons.

This comprehensive plan for stream improvement was made feasible through Nekoosa-Edwards Paper Co.'s development of a new technique that makes practical use of Wisconsin's plentiful supply of scrub oak for pulpwood. The new method starts with using a chemical to kill the oak tree and loosen its tight-clinging bark, which has been the principal previous obstacle to using this species. The following year the tree is cut for pulpwood, and eventually can be manufactured into a satisfactory grade of short-fiber pulp by the kraft process.

Nekoosa-Edwards accomplished a 30% cut in sulphite pollution through a soil-filtration ponding method that started up last year. This method for disposing of spent liquor will be continued. The stepwise new construction program is scheduled to bring the total river improvement to 50% in 1956, to 70% in 1958, and to 78% in 1959.

National Container

Discharge of mill effluent into the relatively small watershed of the Suwannee River required National Container Corp. to provide high degree treatment facilities at its new kraft mill located near Valdosta, Ga. Taking advantage of the topography, company and council engineers devised and built a settling and oxidation system which has enabled the mill to get into operation without causing pollution and gives great promise of purifying the mill effluent to a degree where no untoward conditions will occur in receiving waters. The system consists of alternating settling basins, two oxidation lagoons, and a strong waste surge basin. The settling basins receive fiber-bearing waters discharged after passage through a flotation saveall. The strong nonfiber-bearing wastes are sewered separately and discharged to a surge basin which serves to equalize them. From this basin the waste is pumped into the effluent of the settling basins at controlled rates. The combined effluents then pass successively through the two oxidation lagoons and thence to a canal discharging to a small canalular stream. The latter flows for a distance of about 10 miles before joining the Withlacoochie River. Two small impoundments in the small stream add further to the effectiveness of the purification occurring in the stream and in the lower one fish life is maintained.

A highly efficient recovery and a unique sewering system add to the effectiveness of the entire arrangement. Both William Weir and David B. Lee, state sanitary engineers of Georgia and Florida, respectively, participated to an important degree in developing this project.

Consolidated

In its search for new ways to make useful products from spent sulphite liquor, Interlake Mill, Appleton, Wis., has erected a plant addition to house a newly installed double drum drier. This unit processes the syrupy sulphite concentrate from the mill's big evaporators, producing a dry, flaky material which goes to some customers in this form and for other customers is powdered in a hammer mill.

Interlake mill, a division of Consolidated Water Power & Paper Co. of Wisconsin Rapids, last year installed a half-million-dollar evaporator plant that processes all of its spent sulphite liquor. This material as collected from the mill's nine digesters contains about 12% sulphite solids. The evaporators concentrate it to 50% solids, boiling it down to about one sixth its original bulk. In this form it can be burned in the mill's boilers for industrial fuel, thus returning in fuel value part of the cost of concentrating. Substantial fractions of the 30,000 to 35,000 gallons of concentrate produced daily are now being sold in this syrupy form for use in making linoleum paste, as roadbinder which can be economically shipped longer distances than the dilute liquor, and for other purposes.

The newly installed drum drier broadens the potential outlets to include users who require the dry flake or powder form. Principal use for the dried liquor solids is as a dispersant. Typical services: in concrete, to give high strength by dispersing the portland cement particles more evenly through the mixture; in oil well drilling, to hold at the proper consistency the semifluid special muds used to keep the drill bit from overheating and to seal off any geological faults in the rock deep down in the hole.

A 4-in. stainless steel pipe line 7100 ft. long and costing $50,000 installed with necessary equipment will be constructed by Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., to reduce sulphite pollution of the Wisconsin River. Plans and specifications were submitted to state authorities in time to meet a deadline set up in a 1953 official order which requires completion of the project by May 31, 1955.

Consolidated proposes to run the stainless steel pipe line, with a daily capacity of 200,000 gallons, from its sulphite pulp mill to Hunters' Island in the river about a mile north. A lagoon of the seepage or soil-filtration type will be constructed on the island. Geological surveys and consultation with the pollution committee led to selecting this site.

When the lagoon is completed, all collectible sulphite liquor solids from the sulphite mill will be pumped to it for disposal. Sole exception is that the company will continue its program of distributing sulphite roadbinder to public road authorities for stabilizing road surfaces. Consolidated roadbinder experts are currently working with the State Highway Commission and with technical men of the Sulphite Pulp Manufacturers' Research League to develop engineering standards and specifications for the most effective use of sulphite roadbinder.

Rhinelander

Additional capacity to manufacture dried torula yeast from spent sulphite liquor has just now gone into production at the plant of the Lake States Yeast Corp. subsidiary of Rhinelander Paper Co., Rhinelander, Wis.

Until now, maximum daily capacity of the plant was restricted to 11,500 lb. of dried yeast by the tonnage of material that the drying department could handle. A building addition and a high-capacity double drum drier have now been added to open the former production bottleneck and increase daily output more than 10% to above 12,600 lb.

Simplex

Simplex Paper Corp., Adrian, Mich., has opened a converting plant in Crossett, Ark.

This new addition to the growing group of forest utilizers in Crossett will manufacture nearly a dozen different kinds of waterproof paper to supply paper merchants, the building supply trade, and other paper converters.

Head of the operations is James Boulware, Southwest division manager for Simplex, who on May 20 snipped a ribbon across the plant's entrance as the operation was formally dedicated and production was under way. Assisting Mr. Boulware was Horace Vincent of Crossett.

The attractive 20,000-sq. ft. manufacturing building is constructed around the "double reverse roll coating machine"—the heart of production, which is as impressive looking as the name sounds.

This machine is of new design and is unique in the field. Here is a general idea of how it works in the manufacture of asphalt coated paper. Paper from rolls at each end of the machine is pulled toward the center where both strips of the paper pick up heated asphalt. The two coated strips then are pressed together and pulled over rolls that chill the asphalt. Then after rewinding and finishing the 120-in. wide rolls are ready for shipping. Facilities are also available for the manufacture of shorter rolls. If the ultimate use of the paper requires more tensile strength than the paper normally has, it is a simple matter to place fiber glass or jute between the coated layers of paper.

Kimberly-Clark

Even less spent liquor than before will reach the river from the sulphite pulp mill, at Kimberly, Wis., and service to roadbinder customers is being speeded up because of a new method that Kimberly-Clark Corp. is testing to strengthen its roadbinder program.

For some time the mill has operated an adjacent ponding area to which was hauled spent liquor that could not be used on roads because of unfavorable weather or an excess of production. Expectation of state authorities and mill technologists was that the ponded liquor would filter through the heavy clay soil and lose much of its pollutional strength by the time it seeped into the river.

Recent demand from road districts for sulphite roadbinder has been running about 120,000 gallons per day, with only 100,000 gallons being produced by the mill. When regular storage tank supplies began running low and prompt deliveries were endangered, someone remembered the ponding area. Tests showed this ponded liquor was in perfect condition for roadbinder use.

So a big pump was installed at the pond for loading the tank trucks which treat road surfaces. Now any day's excess demand is supplied from the pond, and deliveries continue 24 hours a day. On days too wet for treating roads, the pond's supply is replenished.

Present pond area is 11 acres, but it can easily be increased up to 100 acres. Mill executives are hopeful that the roadbinder program can be substantially expanded next year by filling up a big pond during next Winter and using this stored material when the 1955 roadwork season arrives.

Charmin

The old-fashioned practice of giving the customer something extra for his money—a "baker's dozen"—is not entirely dead, even in this era of high prices.

Recently a student at a Michigan school found this out the hard way as part of his initiation into a fraternity.

Here is a portion of the letter he wrote to John Maloney, vice-president and sales manager for Charmin Paper Mills, Inc., Green Bay, Wis.:

"My project was to take one of your 650-tissue toilet paper rolls and count the sheets. I would like to compliment you on giving us 664 sheets instead of 650."

As proof, he enclosed the extra 14 sheets, consecutively numbered from 651 through 664.

In reply, Maloney explained Charmin's policy of making certain that every customer received full advertised value and added:

"Your honesty is above reproach and we can only add that had you found 636 sheets, we would have stood willing to supply the balance on demand."

St. Regis

St. Regis Paper Co. has completed an approximately $5,000,000 expansion program at the St. Regis Kraft Center in Pensacola, Fla.

This expansion program, which was initiated September, 1953, will increase the flexibility of the Pensacola Kraft Center so that it can produce bleached and unbleached grades of kraft paper for a broad variety of uses.

The expansion program consisted of four major parts: construction of a five-stage bleaching plant, increased water supply facilities, a screen room extension to increase screening capacity; and modernization of the no. 1 paper machine for the production of bleached fourdrinier grades. The new bleaching plant is located on the no. 1 pulp mill site in the area east of the present bleaching plant.

The new bleach plant has a bleaching capacity of 250 tons daily, which is more than triple the Pensacola plant's former capacity.

At present, the new plant is equipped to handle five stages of bleaching—chlorination, first caustic, first hypochlorite, second caustic, and second hypochlorite. Provision has been made for a possible future sixth bleaching stage. Bleach liquor-making facilities have been converted from a batch system to a continuous and automatic system.

Reconstruction of the no. 1 paper machine at the Pensacola Kraft Center was undertaken to enable the machine to handle a 100% bleached product as well as to increase its capacity. The reconstruction was accomplished in little more than two months' time.

Capacity of the new screen room is 250 tons daily, which is sufficient to handle all pulp for bleaching at the Pensacola operations. The fine mesh of the screens provides for a high-grade product.

Engineering design for the reconstruction program was done by the St. Regis Engineering Division. The actual construction work was done by the general contractor, Tidewater Construction Corp.

Flambeau

A method for disposing of spent sulphite liquor never before utilized in Wisconsin beyond an experimental scale will soon be operating at the pulp mill of The Kansas City Star Co., Flambeau Paper Division, Park Falls, Wis. A stainless steel pipe line is being set up to carry a steady flow of spent liquor to an adjacent island. Here spray heads like farm field sprinklers will be installed to spread the liquor across a wide area of land at a carefully regulated rate of flow.

Experiments carried on in recent months by the Sulphite Pulp Manufacturers' Research League near Appleton indicated that this land disposal technique may consume a greater proportion of the wood sugars than does conventional soil filtration, thus reducing the amount of oxygen-consuming material that reaches the river. The Flambeau mill is also employing a tester to make daily measurements of river conditions, to yield definite facts on a performance of the new disposal method.

Gair

Robert Gair Co., Inc., N. Y., has completed a two-year $5,000,000 extension program at the kraft container board mill of its subsidiary, Southern Paperboard Corp., Port Wentworth, Ga.

When completed in June, 1948, at a cost of approximately $16,700,000, this mill included the most up-to-date methods and equipment available at that time. Yet scarcely four years later in order to take full advantage of the advance in techniques and to make other improvements, this extension program was entered into.

The $5,000,000 addition to the chemical and mechanical facilities of this mill has been completed within the estimated expenditure and with a minimum loss of operating time. Daily capacity has been increased to a maximum of 685 tons of finished paperboard, a substantial increase over the original capacity of the mill. Operations to date show improved quality with an important reduction in the amount of pulpwood used per ton of paperboard.

Gair Woodlands Corp., Savannah, Ga., a corporation affiliated with Gair, has established two four-year scholarships of $2000 each offered to outstanding high school graduates to encourage greater interest in the study of forestry and to further the advance of professional forestry.

These scholarships, in the Schools of Forestry at the Universities of Florida and Georgia, were offered to graduates in certain counties of Florida, Georgia, and South Carolina. From the 10 applicants for the Florida award, Charles W. Godfrey, graduate of the Callahan High School in Nassau County, Fla., was the winner, and from the 25 applicants for the Georgia scholarship, Stanford L. Tillman, graduate of Surrency High School, Appling County, Ga., was selected.

West Virginia

Preliminary construction work has begun on a new $2,000,000 waste treatment plant, designed to bring about a large scale reduction in the pollution load at the Covington, Va., plant of West Virginia Pulp & Paper Co. The new waste treatment plant is expected to be in full operation by early next Summer.

Designed for a maximum capacity of 24,000,000 gallons per day, the new installation will treat wastes from the mill's woodyard, pulp mill, chemical plants, the first two stages of the bleaching operation, and the carbon plant. At present levels of production the volume of wastes from these operations runs about 16,000,000 gallons per day.

Extensive pilot plant operations carried out under actual operating conditions for nearly three years indicate that the new plant will remove up to 90% of the harmful solids and organic materials from these wastes.

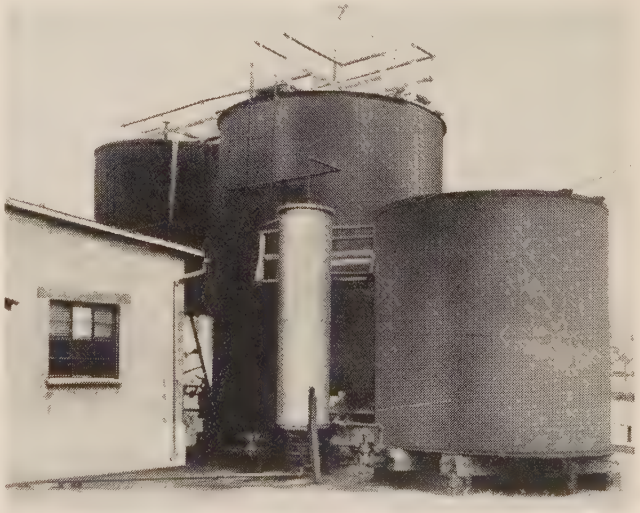
Effluents from the paper mill are scheduled to undergo separate treatment by a different process. Wash waters from the final stages of the bleaching process are highly dilute and will not require treatment.

The decision to invest $2,000,000 in a waste treatment plant from which it will realize no monetary return is one of a series of major steps taken by the company in recent years to reduce the mill's pollution load.

Because no practical method of treating pulp and paper wastes had been developed, earlier pollution abatement activities at Covington were directed toward prevention of wastes at their source. Waste losses detected by continuous metering and sampling installations along the river have been corrected by improved operational procedures and major equipment changes. It was pointed out that pollution abatement was a prime consideration of company engineers in designing new equipment installed as part of the mill's post-war modernization program, recently completed at a cost of nearly $40,000,000.

This large-scale program of process changes and improvement has restored to a normal state about 20 miles of stream previously polluted by mill wastes, the board reported. Records of the Virginia State Water Control Board show that the mill over the past six years has accounted for an over-all reduction of about 40% in the volume of oxygen-consuming solids and organic materials discharged in the Jackson River.

When broad studies indicated that it would be virtually



The waste treatment process of the new $2,000,000 plant at the Covington, Va., plant of West Virginia Pulp & Paper Co., was developed in this pilot plant, the first of its kind in the world. Billions of bacteria consumed the impurities in waste waters in the large center tank, while a settler at right removed them from the treated water to be used again. Hidden by the laboratory building are the tanks and pumps handling chemicals which are fed to the bacteria

impossible to attain ultimate pollution abatement goals through process changes and equipment improvements alone, the company began utilizing all feasible methods of treating its wastes.

The first major installation devoted to the treatment of wastes was a large settling basin capable of retaining about 40 tons of fly ash daily from power plant stack scrubber water. Completed about three years ago the settling basin cost in excess of $100,000 to construct and is maintained at an annual cost of about $20,000.

Early in 1950 the National Council for Stream Improvement reported interesting progress in its experiments for treating pulp mill wastes through a modified activated sludge treatment similar to that used by sewage disposal plants. This work was the culmination of several years' investigation by W. A. Moggio of Louisiana State University, working with the National Council. Many previous attempts had been made without sucess to apply this proccess to the treatment of pulp and paper mill wastes.

The company, which had been a contributing member of the National Council since its formation, sent its pollution abatement technicians to check on the research effort and then began its own laboratory studies in December, 1950.

In August, 1951, the company installed a pilot-scale waste treatment plant at Covington, the first of its kind in the United States. The pilot plant, which processed 50 gallons of wastes per minute, later was modified to conform with specific problems being encountered at Covington. Test runs of this plant were conducted for a total of about three years. Results obtained from the pilot-plant operations, combined with studies of C. J. Velz of the University of Michigan, who evaluated the characteristics of the Jackson River, and annual biological surveys of the stream made by Willis Van Horn of The Institute of Paper Chemistry, Appleton, Wis., resulted in the company decision to attempt the design of a full-scale treatment plant.

An intensive two-week analysis of many variables and round-the-clock tests by W. W. Eckenfelder, of Weston, Eckenfelder, and Hood, provided the finer details necessary and in September, 1953, the engineering design of the treatment plant was begun by Gibbs and Hill of New York City. The engineering data were completed and approved in May and the contract for construction then was let to Tidewater Construction Co. of Norfolk.

The Covington waste treatment plant will be the first in the country to effectively treat wastes from the sulphate pulping process on a scale as large as that required at Covington, where more than 700 tons of paper and paperboard are produced daily. Until very recently such treatment was considered impossible by the industry.

The waste treatment plant being built at Covington will duplicate under controlled conditions nature's function in treating mill wastes.

As a first step in treatment, the mill wastes are run into a primary settling tank, where all the solids are settled out during a retention period of about two hours.

The liquid portion of the wastes then is pumped to a mixing box, which has been "seeded" with bacteria and other microorganisms. The key to the process lies in providing a balanced diet upon which the bacteria can thrive. This is accomplished by adding quantities of phosphorus and nitrogen to the organic materials contained in the waste waters.

The waste liquids, added chemicals, and the gelatinous mass of bacteria, which is called "activated sludge," then are pumped to deep aerating channels. For a period of three hours the bacteria consume the organic materials in the wastes, kept active by oxygen supplied by the air pumped into the aerating channels. By the end of this period the bacteria have consumed from 80 to 90% of the harmful organic material in the wastes. The aerated material then is sent to a final settling tank, where the activated sludge settles during a three-hour retention period, leaving the clear water behind. The settled sludge then is returned to the mixing box for reuse, or to an excess sludge storage tank, and the clear water is released to the stream.

The Covington installation includes one primary settling tank measuring 100 ft. in diameter, with side water depth of 12 ft.; and two activated sludge units measuring 175 ft. in diameter, which includes two aeration channels 25½ ft. in width and 15 ft. deep and two inner settlers 120 ft. in diameter and a little over 11 ft. deep at the side. The sludge storage tank, which has a 24-hour capacity, is 50 ft. in diameter and 20 ft. deep.

Every stage of the waste treatment process will be scientifically controlled by a complex system of instrumentation. The system will be operated from a central start-stop control console, equipped with two alarm systems to warn of any process trouble the instant it occurs.

Stanley W. Hamilton, formerly assistant to Starrett D. Huff who died suddenly on July 14, 1954, has assumed the duties and responsibilities of manager of wood procurement at the Mechanicville mill of West Virginia.

Ohio Box

Another step in the expansion program of The Ohio Boxboard Co. was taken recently with the acquisition of The Empire Box Corp. of Illinois.

Empire's manufacturing plant is located in South Bend, Ind., and its sales offices in Chicago. The company will continue to operate as The Empire Box Corp., Division of The Ohio Boxboard Co., with J. L. Lyons continuing as general manager. Serving in that capacity since 1932, Lyons has been associated with Empire the past 30 years.

The plant has eight printing presses, including one rotary two-color, nine cutters, six straight line gluers, a right angle gluer, and cold water waxing equipment. It currently produces 10,000 tons a year, and employs 250 people. Production is expected to be increased to about 15,000 tons per year.

In acquiring the Illinois Corp., The Ohio Boxboard Co. further extends its "planned packaging" facilities. In addition to producing folding cartons and corrugated shipping containers in the Rittman plant, the company operates the General Carton Co. plant in Cleveland, and The Norwalk Paper Box Co. in Norwalk.

Container branch plants are located in Cuyahoga Falls, Youngstown, Pittsburgh, Pa., and Lockport, N. Y. The Lockport plant—Western Containers—was purchased last April from Western New York Container Corp. and Lockport Products. A two-story main operating building in Lockport, in addition to warehouses, boxmaking equipment, paper stock, and finished products, were destroyed by fire early last month. A modern factory building to replace the half-million dollar fire-razed buildings is now in process of erection.

Founded in 1903, The Ohio Boxboard Co. has grown into the largest industry in Wayne county. The four paperboard mills in the Rittman plant have a daily production capacity of 600 tons. The mill division and the two box shops, together with warehouse facilities, cover an area of approximately 18 acres.

Ontario Paper

Between 1875 and 1895 the price of newsprint dropped $140 a ton. The reason was a new discovery. Newsprint could be made entirely from wood by using something new—long, fibered chemical pulps along with groundwood.

Today at Thorold and Baie Comeau the newsprint machines roll out ton after ton of newsprint made entirely from trees—a testimony of the importance of sulphite pulp in providing Canada with her greatest industry.

But trees in the form of pulp are the basis of many other products besides newsprint—products that are also very important to us. In the course of a year we turn out many tons of "market" pulp, gallons of alcohol, and pounds of vanillin—all by-products of spruce logs.

Have you ever stopped to think of all the other products besides newsprint that started as a log in our "back yard" wood piles?

Take "market pulp" as an example. We make a good deal more sulphite and groundwood pulp than we need for our newsprint machines. That is a form of insurance to make certain that our mills have sufficient raw material available at all times to operate at full capacity. What's left over, we sell—not for newsprint but for many other products.

For example, picnic plates and paper cups are made from free groundwood pulp. This is a different quality pulp from that used in newsprint. It requires greater strength than ordinary groundwood and we developed it to serve the special needs of our customers. It is used by them in the manufacturing of wall boards, ice cream, and butter cartons, and in meat and food containers. Our customers in these fields are naturally particular about quality and cleanliness—and it is our job to provide them with the kind of product they need.

Our unbleached sulphite "market" pulp is also used by many other manufacturers. It is used to make the waxed paper and it turns up at Christmas and other gift-giving times in colored tissue paper wrappings. In fact, the list of end products made from our sulphite pulp is almost unbelievable. Take a look at this list and see how many end uses you were aware of:

Glassine and greaseproof papers for wrapping foods, meats, and cakes.
Boxes, cartons, containers for the food industry.
Wrapping papers, magazine paper, and high-grade bond; coated printing papers for catalog and telephone directories.
Building and plaster boards. Mats for the printing industry.

With such a wide variety of products it is easy to see why we must "tailor" our pulp production to the needs of our individual customers.

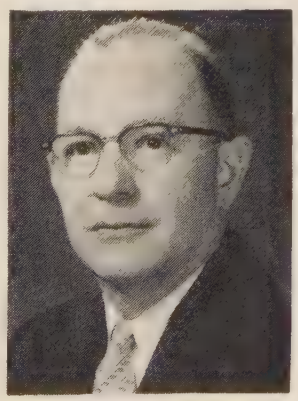
MEAD

Sixteen Chicago Bridge & Iron Co. welded steel structures are playing an important part in the new pulp-making facilities of the Mead Corp. at Chillicothe, Ohio. The new facilities were placed in operation on Oct. 14, 1953.

The new equipment at Chillicothe was designed to add 110 tons of air-dry bleached soda pulp daily. It represents an important addition to the pulp capacity of the mill and a further step in its integration. The pulp is used by Mead's adjoining 11-machine paper mill. The additional pulp capacity furnished by the mill eliminates former shipments of 40 to 50 tons per day of soda pulp from Mead's Kingsport Division in Tennessee.

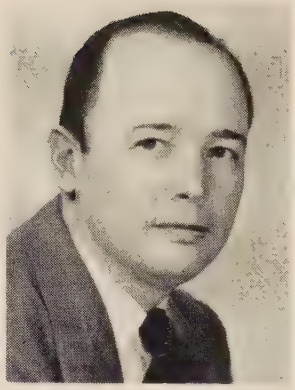
The new pulp mill is designed to handle two kinds of wood. In addition to the "soft" hardwood mix of aspen, willow, cottonwood, yellow poplar, gum, etc. that had been previously used, the mill will handle oak. By using oak, Mead will be able to procure the increased quantities of wood needed for the added tonnage of the new mill from relatively nearby sources. Oak is the most abundant wood in the vicinity of Chillicothe.

An average of 280 cords of wood per day are used at the mill and yield 165 tons of soda pulp. From this pulp 600 tons of paper are produced daily in the Mead paper mill. The paper produced at Chillicothe has been shipped to all corners of the world and is used for magazines, periodicals, labels, stationery, school books, tablets, and direct mail advertising.

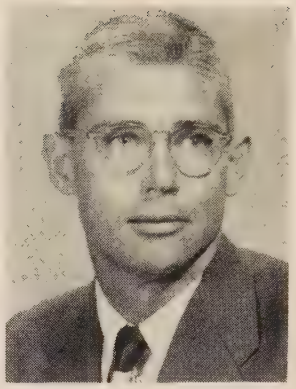


F. H. Niederauer, Mead Corp.

In 1890 the Mead family purchased the land and mills of the Ingham Mills and Co. in Chillicothe, Ohio, and in 1905, George H. Mead founded The Mead Pulp and Paper Co., known today as The Mead Corp. The building and adjoining premises of the corporation occupy more than 75 acres.



G. H. Sheets, Mead Corp.



J. R. Taggert, Mead Corp.

Edward H. Niederauer has been appointed division manager of the Kingsport Division of The Mead Corp. George H. Sheets will be assistant division manager, and John R. Taggert has been promoted to general paper mill superintendent.

MCCORMICK MONUMENT

An appropriation of $25,000 has been provided in the town of Baie Comeau, Quebec, budget for the year 1954 for the construction of a monument to Colonel Robert R. McCormick, pioneer in the industrial and economic development of the North Shore of the Gulf of St. Lawrence.

I.P.

The following items are taken from the president's report to the shareholders of the International Paper Co.

1953 was a record-breaking year for the International Paper Co., from the standpoint of both the production of primary grades and total sales dollars. For the first time production exceeded 4,000,000 tons, while total sales were $673,508,000, about $36,000,000 higher than in 1951, previously our best year.

Net profit from operations amounted to $58,542 as compared with $52,126,000 in 1952. On the basis of the common shares outstanding after last December's stock dividend, this was equivalent to $5.89 per share in 1953 and $5.23 in 1952. In addition to the operating profits in 1953, there were special nonrecurring items totaling $5,393,000, which produced an additional 55¢ per share.

For the first quarter of 1954 net profit totaled $15,361,000 or $1.55 per common share as compared to $13,796,000 or $1.39 on the present common shares in 1953. However, the improvement is due primarily to the expiration of the excess profits tax. There was a slight drop in both production and sales, and profit margins were narrower. Earnings before taxes declined almost $3,000,000.

Looking ahead for the year, considerable new productive capacity has recently come into the industry and additional capacity will begin production during the course of the year. Over the longer term, this will be absorbed, as we can look forward with confidence to a continuing steady growth, both in demand and in the development of new uses for paper. This will, however, take time and over the coming months the industry is not likely to find sufficient immediate demand to operate as close to capacity as at present, even though total production tonnage may well remain at or near present levels.

Last year in the United States and Canada I.P. processed more than 6 million cords of pulpwood to make a little more

than 4 million tons of pulp and paper. But we are a *growing industry*—in an expanding economy—in an Age of Cellulose—with new products and a growing use of present products made from wood fiber. Looking ahead we must anticipate an increase in our production and in our need for wood.

In the United States and Canada today our companies own or have under lease nearly *18 million acres* of forest lands. This is approximately the area of New Hampshire, Vermont, and Massachusetts combined.

In the United States we own some 4 million acres of forest lands, and we are continually adding to this vast forest farm whenever acreage comes into the market at favorable prices and in good locations with respect to our mills. In addition, we have over 300,000 acres under long-term leases, so that our total holdings are well over $4^1/_4$ million acres.

In Canada, the bulk of the wood comes from $13^1/_2$ million acres of Crown lands, which our Canadian companies have under lease from the provinces of Quebec and New Brunswick. In addition, they own in fee nearly 450,000 acres.

But acreage alone does not tell the story. The critical factor in planning a wood supply is not acreage, but growth. How do we stand on growth?

In Canada, we used nearly $1^1/_2$ million cords of wood in 1953. We estimate that the growth on the lands our Canadian companies own and lease was materially greater than this total. These Canadian woodlands are capable not only of supplying present requirements on a sustained yield basis but also of meeting expanding needs in Canada.

In the Northeastern section of the United States, our mills now consume over 300,000 cords of wood per year. Our surveys show that this amount of wood could be supplied from our own forest acres. However, we will probably continue to buy large amounts of wood from farmers and landowners.

In the South, our foresters estimate that when growth stocks have been fully built up the quick-growing pines in our woodlands can produce each year half of the $4^1/_2$ million cords which our Southern mills consumed last year.

It is not our aim to make our own land produce all the wood we need. We believe we will always want to buy a large part of our wood from others in the South and a substantial percentage in other areas.

Our Southern Kraft Division has taken leadership in setting up a network of 35 wood-collecting yards in seven states. The nearby landowner can bring his wood to one of these International Paper Co. collecting yards at any time—in any amount—and sell it. These collecting yards serve two important purposes: they open up to us important new sources of wood for our mills, and they create pulpwood markets for farmers and landowners who never had an opportunity before to think of their trees as a cash crop worth growing year after year. The economics of mechanized large-scale wood handling makes the program practicable.

In Canada, the Canadian International Paper Co. has taken another approach to provide a stable market for the small woodlot owner. The dissolving pulp mill at Hawkesbury, Ontario, has been redesigned to use the hardwoods which are growing on farms in that locality. This mill was literally re-engineered around the farm woodlot. Its capacity is keyed to the annual growth on those woodlots.

We have been doing a large-scale educational job in the South for many years now. By example and demonstration of good forest practice on our lands, our foresters help give farmers and landowners an understanding of tree farming.

Meanwhile, we see great possibilities for increasing the long-term output of our own forest acres.

We are appoaching increased production in many ways. For one thing, we are doing a very large tree-planting job in the South. During the last planting season, we put out $17^1/_2$ million seedlings on our own lands. In line with our objective of encouraging good forest management on the part of others, we helped farmers and landowners to plant $12^1/_4$ million additional seedlings on their lands. It is interesting to realize that during the past 8 years we have planted on our lands—or made available to others for planting—124 million seedlings. At the rate of 1000 trees per acre that is a man-made forest of 124,000 acres.

Through research work in a number of large experimental forests in the United States and Canada, our companies are seeking better and more economical ways of cutting on their forest acres for maximum reproduction and growth. Our laboratories are continually searching for ways to process more types of wood. Meanwhile, the mills are finding ways to use pulp more economically in the production of better papers.

Pure-Pak

The vast dairy industry of the Minnesota-Wisconsin area will be served in a new plant manufacturing Pure-Pak paper milk containers under the Single Service Division, International Paper Co.

To be located on new U. S. Highway 55 in the Golden Valley area of Minneapolis, the new unit will consist of 64,000 sq. ft. and will have a rated monthly capacity of approximately 40,000,000 paper milk containers of all sizes. The converting plant will be on a 26-acre site adjacent to the right-of-way of the Minneapolis, Northfield, and Southern Railway.

Weyerhaeuser

Weyerhaeuser Timber Co. has started construction of a new plant which will manufacture particle board from planer shavings. The plant, which will be completed early in 1955, is being erected at the Coos Bay branch.

Particle board is produced by adding synthetic resins to heated particles of wood and pressing this combination into panels. The board looks and "works" like lumber; it can be sawed, nailed, drilled, painted, or refinished.

All wood raw material for the plant will be obtained from planer mill shavings left over from the company's sawmill operations, officials said.

Time-Life

Few at Time Inc. are engaged in such steady investigation of the future of the company as the 89 men and women at the Springdale Laboratories in Springdale, Conn.

For the most part, these people are content to limit their thoughts of the future to the next decade, but occasionally the clouds in the crystal ball disperse long enough to give them a glimpse of a future day when *Time* and *Life* may not even be printed by presses as known today, but by some of the new, experimental techniques still on the horizon of graphic arts research.

Shape of Things to Come

These glimpses into the future are called "blue sky thinking" by people in the New York production department, and "imagineering" by the Springdale staff. But call them what you like, they provide an interesting and thought-provoking picture of the shape of things to come.

Most of the time, however, the people at Springdale restrain their impulses to take off into the blue sky, and keep their feet solidly on the ground. At present, they are fulfilling a basic need for research in printing. This work is not done by wild flights of fancy, but by careful, cautious, painstaking work of a nature which is rare in the printing industry.

Research Investment

In a recent report on research, Roswell Fisher, head of Time Inc.'s research and development department, stated that 30 leading United States industries were spending annually about 2% of their gross sales on research, while companies involved in printing were spending much less (between $^1/_8$ and $^1/_4$ of

1%). An exception in the publishing world is Time Inc., which last year invested $1,675,000 in research, concentrated at its Springdale Laboratories. Here, in a 33,000-sq.-ft. plant, 55 technicians, cooperating with Time Inc.'s production department, its suppliers, the printing equipment builders, and many of the large research establishments of the United States search for new methods of printing which may well become standard operating procedures for Time Inc. and the printing industry in the future. Their goal is to make Time Inc.'s printing better, faster, and cheaper than ever before.

The printing problems confronting Time Inc. are unique in the publishing field. The production of *Time* alone is enough to make printers sleep restlessly at night, but even that enormous task pales in comparison with *Life*.

Speed, profuse use of color, and gigantic print orders make *Life* what is probably the most difficult printing assignment in the world.

Speed, Speed!

The 27 presses which print *Life* run at a speed of 1000 f.p.m., which makes them very fast presses indeed; but the men at Springdale, whose job it is to find improvements for even the best of existing equipment, are now taking the "bugs" out of an experimental press designed to double this speed.

Yet even if some obliging genie produced a miracle press ready to roll, the job facing *Life*'s printers would only have begun. For example, in high-speed presses, inks must dry as fast as the press can print, and binders must make magazines as fast as the printed paper is turned out.

At printing speeds of 2000 f.p.m., old-fashioned printing plates would fly loose from their cylinders and go sailing across the pressroom.

The solution of one problem calls for the solution of 50 more affecting the whole process of printing. This is what the men and women of Springdale mean when they describe their work as cooperative. No single person, no single talent, could solve the problems they face.

Pooled Talents

For this reason, it is impossible to credit achievement at Springdale to individual people. Problems are solved on a cooperative basis at Springdale, where departments are arranged much like at a small university. These departments are: chemical (headed by Robert M. Leekley); development (Paul J. Thoma); electronics (Nathaniel Bishop); mechanical (Harry W. Faeber); and methods engineering (David H. Taylor). Each of these departments has a large degree of autonomy, but at scheduled conferences and at lunch time the air is thick with swapped ideas.

Typical Projects

Working in concert, these departments are responsible for such specialized innovations as the laminated plate, the internal lock-up cylinder and the new high-speed press, all of which are part of a program named "195Y." This program, which will go into effect before the 1950's are finished, will provide Time Inc. publications with the best there is in magazine production machinery.

But the work of a research organization is never truly finished. When and if the problems of doubling the present printing speed are solved, Springdale will pose itself new problems, perhaps to double the speed again. Finding solutions takes time, and most industrial research organizations realize that it takes ten years before their "researching" begins to pay off.

On this subject, Dave Taylor, methods engineering head of Springdale, said: "Sometimes the biggest part of the job of solving a problem is stating it in exact terms." Springdale devotes a lot of time just to the study of Time Inc. production problems. Often a year or more of such study (both engineering and economic) will be done before a research problem is approved and taken off the drawing board.

Experimental Press

One of the most striking things a visitor sees on a visit to Springdale is an experimental *Life*-size press, built in cooperation with Goss Printing Press Co., which takes up half a room big enough to hold a dozen bowling alleys. This press, through which a man can wander without stooping more than once or twice, does not even sound like older presses about the country which often rumble, snap, and grunt as they turn out their finished pages.

This press chants as it works, and the paper comes off the 4-ft. rolls with a smooth, unhurried hiss. Despite its size and massiveness, it is beautiful, with the beauty common to all fine machinery, and its gleaming steel rollers shine as if they were lit from within.

The high speed of this press demands that ink be dried in a fraction of a second. This is done with Springdale-developed drying apparatus. Because it is new and loaded with new ideas, the press is surrounded with men who watch its controls and listen to its heartbeat.

When something goes wrong, they may redesign a small part on a block of drafting paper, and another "bug" has been removed from the press. As the experimental press nears its final form, these changes get less and less frequent.

One unexpected disruption in the press tests was caused by two racoons who sneaked into the press from a drain in the floor. The only damage, aside from the few minutes of delay while they were being pursued, was a bitten finger on the hand of the technician who ejected them.

In other parts of the building, men and women are working on different aspects of the printing problem. The methods engineering department has the job of applying economics to printing, and determining where present methods are financially inefficient. Here, if anywhere, what Springdale has done and will do turns up in dollars and cents instead of metal and machines. To date, the company has spent $12,500,000 on Springdale (about a third of it on bricks and mortar for the plant itself and the rest on research).

Not all the savings which Springdale makes possible are in the future. At present, Springdale development is saving the company a large part of $4,000,000 a year.

No Pokeberries

Moving on from the financial aspects of Springdale, a visitor might wander into the chemistry lab. Some exotic chemicals were required by the earliest printers, who made their inks out of pokeberries and dragon's blood. But there are no pokeberries in the small, well-stocked lab at Springdale, and the nearest thing to a dragon is a furious little bunsen flame. The room is flooded with yellow light to prevent contamination of photosensitive chemicals, and on the tables the contents of intricate pieces of glassware bubble and wheeze softly as the chemists' experiments go on in their vitals. Chemistry has a great many applications to modern printing, and experiments of all sorts are being carried on in this room.

Elsewhere in the building, engraving processes are being investigated. Here, the new science of electronics is being applied to the old art of photoengraving through the "Scanner," a Springdale-developed device which separates a full-color photograph into each of its four component colors.

Nonexistent Gears

In a large room on the second floor, mechanical engineers are trying to fit nonexistent gears to nonexistent shafts, designing machines which will not be actually tangible for years to come.

Most of the time, the men at Springdale keep themselves firmly down-to-earth, but sometimes over a cup of coffee, a bit of "blue sky" shows up even in the brownest eyes, and the Springdale staff may be heard talking in a strange tongue with words like "magnitography" and "photodensitometry"—all but untranslatable to the layman.

But whether or not the layman knows or cares about printing research, he can understand the better colors and the faster news that are its results.

The payoff for this extraordinary research is in the hands of the reader, who buys the magazine on the newsstand for 20 cents.

—by Roderic Hodgins in *Productionwise*, April, 1954.

Thilco

After World War II, Thilmany Paper Co., Kaukauna, Wis., began a long-range plan of modernization and improvement. Since that time new additions and improvements have been made, from the coal yard through to the shipping department. Currently, there are four large projects under way.

At the Lower Mill, an extension to the old recovery building is being constructed to house the new lime kiln. The old kiln, unable to handle present and future requirements, is being retired after a good many years of faithful service.

At the Upper Mill, a long-awaited warehouse building will occupy the space immediately behind the Union Division building. Adding 20,000 sq. ft. to the warehousing facilities, the building will also house an ink and solvent storage room that has been needed ever since the expansion of the decorating facilities. Thilmany is spending about $50,000 for that building . . . just one of the many added improvements that have been made and will be made.

The two other projects at the Upper Mill involve the converting and office operations . . . both vital to continued efficiency and low-cost operation. The new wax department occupying the space left when machines 1 and 2 were retired, will be one of the most modern in the country, with 72-in. squeeze-roll coater and two 72-in. laminators to handle the volume in the wax department.

The proposed office addition will be located over the front part of what used to be no. 1 and 2 machine rooms. This will leave manufacturing space available that might otherwise have been lost.

As a measure of Thilco's growth, it is interesting to note that in 1946, the company paid $71,364 in taxes to the city of Kaukauna; while in 1953 Thilco paid $250,572. The reasons for this large increase have been the large additions of equipment, which, after deductions for abandonment of obsolete equipment, have increased Thilco's tax assessment over $5,000,000.

Rayonier

As many as seven different sources of income can be obtained from properly managed woodlands, according to a new booklet issued by Rayonier and offered free to farmers and landowners in Georgia.

The booklet also describes how to plan a tree crop for deriving maximum income. It explains modern methods of "weeding," fire control, planting methods, thinning operations, as well as how to obtain the free use of Rayonier equipment and the help of Rayonier foresters.

Rayonier foresters have numerous exciting projects under way, all designed to assure a maximum wood yield per acre per year.

Foresters still have a great deal to learn about the different methods of cutting timber. In some areas clear cutting appears to produce maximum amounts of wood, while in others, selective cutting is used. Rayonier foresters have a number of important studies under way which will ultimately tell them which method of cutting will produce the most wood.

Whenever nature plants an area she is extremely profligate, crowding one acre with thousands of young trees. Ultimately, most are crowded out by a few hundred trees most favorably located. Rayonier foresters, in both the Southeast and Northwest, are conducting many thinning operations to determine the ideal time for thinning as well as obtaining some wood supplies from thinners. Nature can be helped to produce more wood by good thinning programs.

Chemically poisoning trees is yet another project of Rayonier foresters. In some cases poison is applied to control weed trees. In other experiments attempts are made to kill trees so that the bark falls off thus reducing that costly operation at the mill. This is one of the research areas where the chemist in the laboratory and the forester in the woods work closely together on an important project. Their results will determine whether tree poisoning adversely affects Rayonier's high quality in its finished products.

A recent experiment in the Northwest is the limbing of trees. In these operations, tree limbs are removed part way up the trunk to determine whether this affects a tree's growth and the total amount of wood the tree will ultimately produce.

Soil studies are an integral part of tree research. Rayonier's forestry division has established a soils-testing laboratory in order to determine what soils will produce the most wood. The result of these experiments could point the way to the use of chemical and other fertilizers for obtaining the best wood yield.

Rayonier does not rely only upon the proved, natural species. Sample plots of exotic trees have been planted to find out whether or not the new species in an area will grow faster than the native varieties. For example, southern pine has recently been planted in the Northwest to see how it will thrive thousands of miles from its native habitat. It is still too early to predict any results from this rather dramatic experiment.

Such experiments are long range in nature, and several years are required before initial results can be tabulated. But undoubtedly, Rayonier believes, the results of this carefully guided scientific program will be reflected in a maximum amount of wood at a sustained yield basis from its woodland tracts.

Hand in glove with Rayonier's research efforts is a vast conservation program, also under the management of the forestry division. An ever present danger to forests is fire. In order to minimize or, if possible, eliminate the criminal waste of wood from forest fires, Rayonier maintains highly efficient fire detection and suppression units. In the Southeast the problem is greatly complicated by a few careless landowners who use fire methods to clear their lands. Rayonier forest lands are protected by trained organized units employing everything from lookout towers, airplanes, and motorized units to fire hose, depending upon water availability. In the Southeast a fire is usually confined to less than 10 acres, but the fire problem is much different in the Northwest, where, although fewer fires occur, their chances of being catastrophic are much greater.

In the Southeast, Rayonier plants thousands of acres of cut timber lands annually. For the 1953–54 planting season, about 7 million pine seedlings were planted in Georgia and Florida, and plans call for upping the number to 10 million for the coming year. Survival of the mechanically seeded areas is quite high, sometimes running to 90%. Within 15 to 20 years such rewooded lands start producing wood for the pulp mills.

Howard W. Hiley has been appointed assistant manager of industrial relations of Rayonier, Ralph J. Kutchera, project engineer for Ebasco Services, Inc., in charge of construction of Rayonier's chemical cellulose plant at Jesup, Ga., has been appointed chief engineer of Rayonier's Hoquiam, Wash., engineering division. John B. Gray has been named assistant resident manager at the Port Angeles, Wash., division of Rayonier.

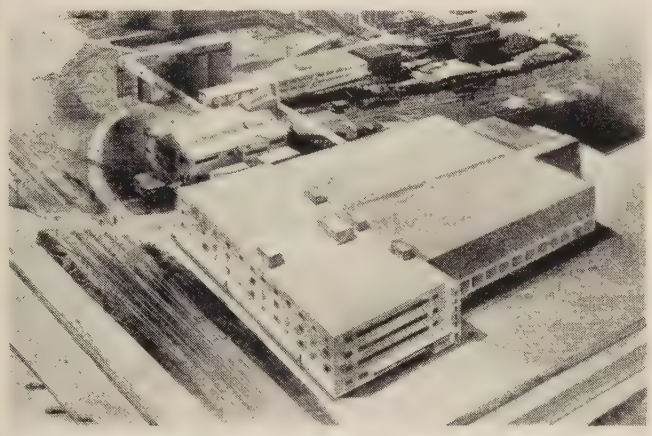
Downing

Charles W. Evert has retired after 30 years with Downing Box Co., Milwaukee, Wis. Mr. Evert will continue with the

company in a consulting capacity. New officers are George B. Downing, president, Robert H. Christy, vice-president and secretary, Arthur F. Fenzl, assistant secretary and treasurer.

SCOTT

Scott Paper Co., Chester, Pa., has acquired all of the assets of Detroit Sulphite Pulp and Paper Co., Detroit, Mich. Detroit Sulphite owns and operates a plant comprising a bleached sulphite pulp mill with a rated capacity of 150 tons per day, six paper machines, and converting equipment.



Architect's drawing shows Scott Paper Co.'s new Everett, Wash., paper mill and the converting and shipping building. Present construction includes the section of the building at left background, which houses two paper machines. Three floors of the converting building in the foreground are also currently in use and a fourth floor is nearing completion. Two additional paper machines will be installed in the new building illustrated at the right behind the converting and shipping building

Scott has also acquired a half interest in Westminster Paper Co., New Westminster, B. C. Westminster manufactures and sells in Canada an extensive line of sanitary paper products. Its plant comprises a groundwood mill, three paper machines, and converting equipment.

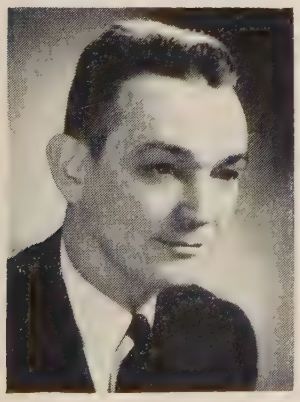
VULCANIZED FIBRE

William H. Harbaugh and John F. Bishop have been appointed manager and assistant manager, respectively, of the Kennett Square, Pa., plant of National Vulcanized Fibre Co., Wilmington, Del.

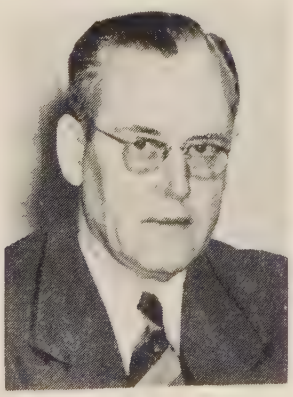
National Vulcanized has published a novel brochure describing Phenolite, a laminated plastic material.

PERSONAL PRODUCTS

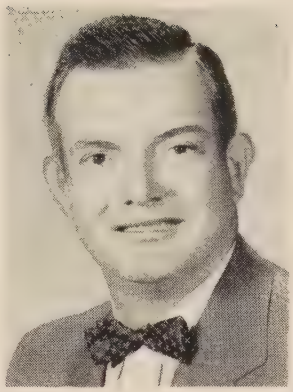
Willis Gleed Coe has been appointed vice-president in charge of manufacturing of Personal Products Corp., Millstown, N. J. Walter Metts has been named senior vice-president of the company.



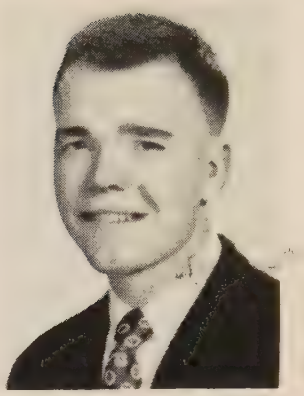
W. G. Coe, Personal Products Corp.



Walter Metts, Personal Products Corp.



J. E. Jack, Sorg Paper Co.



S. M. Rollinson, Institute of Paper Chemistry

SORG

John E. Jack has been appointed production assistant of refining and coloring of Sorg Paper Co., Middletown, Ohio.

CROCKER

Douglas A. Crocker, former assistant secretary of the Tissue Association, Inc., who has been operating as a consultant on paper and paper products, has been with General Service Administration as a paper consultant since June 21.

CHEMICAL EXPOSITION

The Eighth National Chemical Exposition, to be held in the Chicago Coliseum Oct. 12 to 15, 1954, will feature a symposium on exposition marketing of chemicals.

I.P.C.

Samuel M. Rollinson has been awarded the 1954 Westbrook Steele gold medal for the most outstanding doctoral thesis produced by the graduating class of The Institute of Paper Chemistry, Appleton, Wis.

The four graduates of the Institute who received the Ph.D. degree at Lawrence College Commencement in June are now employed as follows: William H. Hoge is group leader in fundamental research with Oxford Paper Co., Rumford, Me.; Victor F. Mattson is on the research staff of Mead Corp., Chillicothe, Ohio; Samuel M. Rollinson is a research chemist at St. Marys Kraft Corp., St. Marys, Ga.; C. Edward Taylor is assistant to the paper mill superintendent at the Port Townsend, Wash., mill of Crown Zellerbach Corp.

UNIVERSITY OF MAINE

Graduates of the University of Maine this year who have accepted employment in the pulp and paper and allied industries are as follows:

Barker, E. R., III, 4 yr. P&P, Albany Felt Co., Albany, N. Y.
Bellefontaine, W. F., 4 yr. P&P, U. of Me., B.S. (Ch.E.)
Crump, J. G., Jr., 4 yr. P&P, Fraser Paper Co., Madawaska, Me.
Dimitre, L. R., 5 yr. M.E., S. D. Warren Co., Cumberland Mills, Me.
Edgerton, D. S., M.S. P&P, Rogers Fibre Co., Bar Mills, Me.
Emery, N. W., Jr., M.S. Ch.E., Scott Paper Co., Everett, Wash.
Htoo, M. S., M.S. Ch.E., International Paper Co., Glens Falls, N. Y.
Majani, B. E., 4 yr. P&P, graduate work, U. of Me.
McKenney, J. A., 4 yr. P&P, International Paper Co., Chisholm, Me.
Pease, W. E., 4 yr. M.E., M.S., P&P, Great Northern Paper Co., Millinocket, Me.
Perkins, C. D., 5 yr. Ch.E., St. Regis Paper Co., Bucksport, Me.
Smiley, D. S., 5 yr. Ch.E., International Paper Co., Glens Falls, N. Y.

Thorndike, W., M.S. Ch.E., S. D. Warren Co., Cumberland Mills, Me.
Touchette, R. V., 5 yr. Ch.E., Eastman Kodak Co., Rochester, N. Y.

Syracuse

Graduates this year of the Dept. of Pulp and Paper Technology, State University of New York, College of Forestry, who have accepted employment in the pulp and paper and allied industries are as follows:

Andrews, William J., graduate student, N.Y.S.C.F.
Bernhardt, David, R., Oxford Paper Co., Rumford, Me.
Bubb, Olive, Dixie Cup Co., Inc., Easton, Pa.
Caswell, Robert F., Jr., St. Regis Paper Co., Deferiet, N. Y.
Cessna, Frank L., Jr., New York & Pennsylvania Co., Lock Haven, Pa.
Clark, Philip C., Champion Paper & Fibre Co., Canton, N. C.
Dalheim, Stuart, A., Graduate Student, N.Y.S.C.F.
Goerner, Basil S., Champion Paper & Fibre Co., Pasadena, Tex.
Gorbatsevich, Serge N., graduate student, N.Y.S.C.F.
Hazard, Sherrill J., Great Northern Paper Co., Millinocket, Me.
Hern, James F., Nopco Chemical Co., Harrison, N. J.
Hoban, Robert F., Sandoz Chemical Co., New York, N. Y.
Knapp, Blair, S. D. Warren Co., Cumberland Mills, Me.
Lucken, Trygve C., Riegel Paper Corp., Milford, N. J.
Maier, Fritz, West Virginia Pulp & Paper Co., Mechanicville, N. Y.
Marder, Herman L., graduate student, N.Y.S.C.F.
Mayhood, Charles H., Great Northern Paper Co., Millinocket, Me.
Schwartz, Peter J., Robert Gair Co., Piermont, N. Y.
Shaughnessy, William J., Albany Felt Co., Albany, N. Y.
Silliman, Richard L., West Virginia Pulp & Paper Co., Mechanicville, N. Y.
Smith, Walter P., Dow Chemical Co., Midland, Mich.
Sobolev, Igor, Graduate Student, N.Y.S.C.F.
Sullivan, Thomas F., Hartford City Paper Co., Hartford City, Ind.
Swenson, Roy S., Great Northern Paper Co., Millinocket, Me.
Tiffany, Clyde, Oxford Paper Co., Rumford, Me.
Vanzo, Edward, graduate student
Wallace, Douglas M., S. D. Warren Co., Cumberland Mills, Me.
Williams, Charles B., Riegel Paper Corp., Milford, N. J.
Zulch, Robert H., Champion Paper & Fibre Co., Canton, N. C.

Western Michigan

Graduates of Western Michigan College this year who have accepted employment in the pulp and paper and allied industries are as follows:

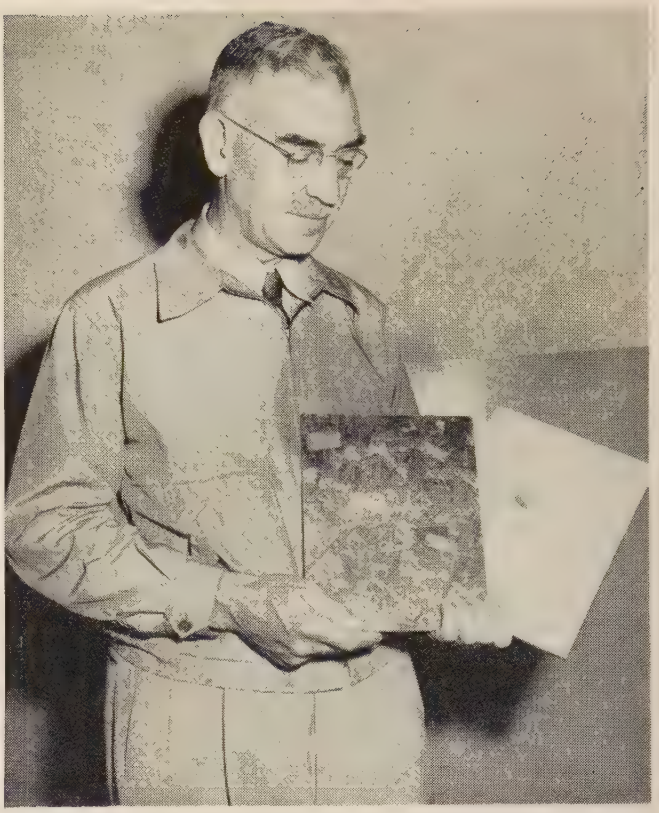
Breton, Andre, Societe des Papeteries Aubry, Croisset-les-Rouen (S.I.), France.
Maves, Kenneth L., Bergstrom Paper Co., Neenah, Wis.; at present, U. S. Army.
Triplett, John E., American Boxboard Co., Grand Rapids, Mich.
Witters, Robert J., Marinette Paper Co., Division of Scott Paper Co., Marinette, Wis.; at present, U. S. Army.

New Building Board

Construction is under way at Sandpoint, Idaho, of a $750,000 plant for the production of a new type of building board from sawmill wood waste.

James d'A. Clark, of Longview, Wash., is the inventor of the new process, which has been developed during the past $2^1/_2$ years at the Dover research laboratory of the Pack River Lumber Co. The Clark process produces a board with properties approaching those of natural wood, and uses slabs, edgings, dead timber, and tops. These raw materials are reduced to wafers about $1^1/_2$ by 1 by $^1/_{32}$ in., mixed with a small amount of resin and hot pressed to form attractive panels for interior use. Panels may be from $^1/_8$ to 6 in. in thickness. The process is entirely automatic and little hand labor is involved. Panels 4 by 16 ft. will be produced at the new plant, which will have a capacity of 50 tons per day.

All the equipment to be used in the plant is of new design, and is being engineered by Sylvan Engineering Co., Chicago, of which Mr. Clark is president. Sylvan's vice-president, Robert Lambert, formerly of Weyerhaeuser Timber Co., is in charge of engineering of the new plant. A novel feature



J. d'A. Clark demonstrating new board

of the huge platen press is its rectangular cylinder, 4 by 16 ft. The waferizer, also of new design, cuts the wood waste across the grain to produce the thin wafers of which the board is formed.

For variety of surface, the board can be faced with any desired species of wood wafer. The finished product has similar properties to plywood but is somewhat denser.

Safety

The National Safety Council, 425 N. Michigan Ave., Chicago, Ill., has published the following booklets: "What's in It for Me?" (employee training booklet), "Two-Wheel Hand Trucks," and "Safety Devices and Ideas."

Packaging Course

Columbia University is offering its evening graduate course in Package Engineering for the fourth time beginning Sept. 29, 1954. Given under the direction of Frederick C. Winter, the course will include lectures by 18 men from the packaging industries.

Packaging Forum

The 16th Annual Forum of the Packaging Institute will be held at the Hotel Roosevelt, New York, N. Y., Oct. 25–27, 1954. Subjects to be included in the seminars will be: Testing and Specifications for Packaging Materials, What Industry Is Doing to Educate and Train Its Packaging Employees, Adhesion as an Engineering Function, Problems of Drug and Pharmaceutical Packaging, the Last Word in Package Printing Processes, New Developments in the Formation of Packages from Heavy Gage Films, Problems

A. E. Cleghorn has been named Executive Vice-President, National Aniline Div., Allied Chemical & Dye Corp., New York, N. Y.

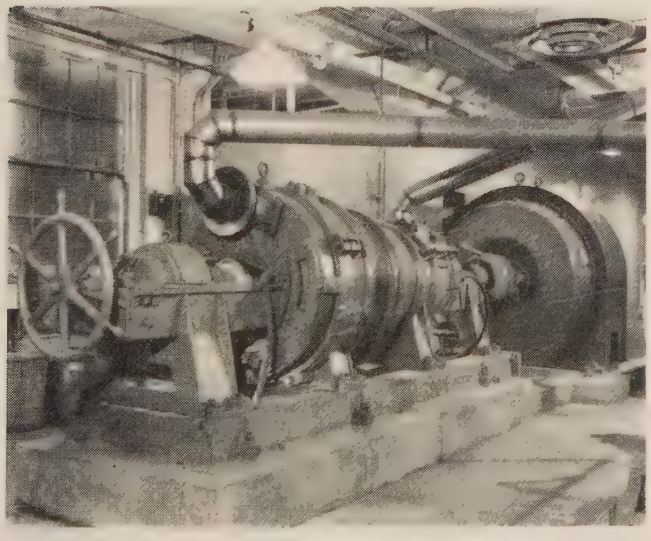
Relating to the Newest Types of Shipping Containers, Line Production of Packages with Special Emphasis on Down Time and Factors Affecting This Form of Lost Production, Statistical Methods and Their Application to Quality Control, Controlling Color and Gloss on Printed Packages, Odor and Moisture Control in Packaged Foods, Flexographic Printing.

ELLIOTT

Elliott Co., Jeannette, Pa., a recent new sustaining member of TAPPI, needs no introduction to the industry. The company was organized in 1901 and is perhaps best known as a manufacturer of power plant equipment. Elliott turbine-generators, mechanical drive turbines, deaerating feedwater

Aerial view of Elliott Co.'s Jeannette works

heaters, condensers, strainers, and tube cleaners have been used in the power plants of paper mills for many years. The company has built large motors at its plant in Ridgway, Pa., the former Ridgway Dynamo and Engine Co., for many years. With the acquisition of the Crocker-Wheeler Electric Co.



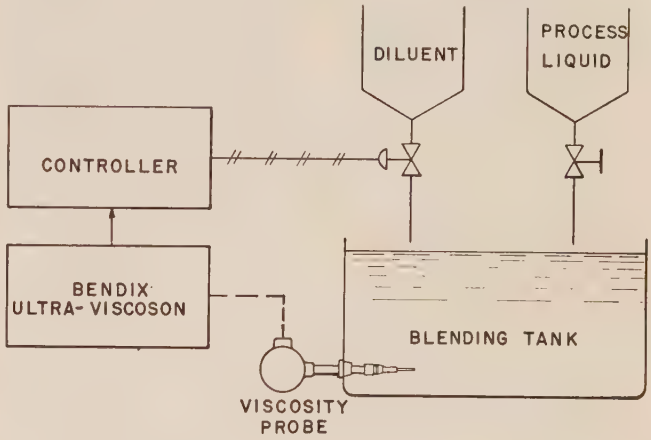
An Elliott 350-hp., 400 r.p.m., 2300-v. splashproof synchronous motor driving a jordan

some four years ago the company extended its line of electric motors from the largest sizes down to 1 hp. With this size range it is able to furnish practically any motor required by the paper industry for driving process equipment such as jordans, refiners, and pumps.

BENDIX

The Cincinnati Division of the Bendix Aviation Corp., has made some important advancements in its revolutionary new viscosity measuring instrument, the Bendix Ultra-Viscoson. This instrument, utilizing ultrasonic principles, is now offered in a complete line of indicating, recording, and control systems which feature a new approach to process control through viscosity.

The versatility of these systems can be emphasized by the



fact that they are presently being employed very successfully to control fuel oil blending, fractionation of lubricating oils, asphalt oxidation, and asphalt cutback in petroleum refineries and fuel atomization in conjunction with open-hearth furnaces in the steel industry. Marked success has also been achieved with laminating resins, gravure inks, and interface detection.

EGAN

Edward F. Egan of Frank W. Egan & Co., Bound Brook, N. J., recently returned from Europe after starting up production operations, and visiting Egan polyethylene coaters in plants located in England, Belgium, France, and Sweden. He also visited customers in Italy, Scotland, Switzerland, Germany, and Denmark.

DARD HUNTER MUSEUM

The Dard Hunter Paper Museum, located for the last 15 years at Massachusetts Institute of Technology, will be moved to The Institute of Paper Chemistry at Appleton, Wis.

The Hunter Collection, the world's finest, illustrates papermaking from its invention in the year 105 A.D. to the present. In 1939, Karl Compton, then president of M.I.T., appreciating the importance of the collection in Hunter's possession, proposed that it be brought to Cambridge for proper display. It will be transferred later this year to Appleton from the Charles Hayden Memorial Library, where it is now exhibited.

The Museum contains specimens of the first papers made from such substances as wood, straw, thistle-stalks, corn-husks, leaves, potatoes, cabbage stalks, and many other fibers. The original watermarks, both ancient and modern in the collection, run into the thousands. The decorated papers, most of which are Oriental, number over 20,000 specimens. Many rare manuscripts, early engravings, and out-of-print books describe the evolution of papermaking equipment and processes. Included in the display of tools and appliances for making paper by hand are items from China, the birthplace of paper.

The collection has been used extensively by workers in textile design and in graphic arts, classes in botany and library science, and scholars and investigators in various fields.

Dard Hunter, who will be the Director of the Museum, has

devoted 40 years and traveled over a quarter of a million miles in building this unique collection.

He has become an international authority on handmade papers, and his assistance to lawyers and librarians in identifying documents was recently the subject of an article in a well-known weekly magazine. Hunter is the author of 23 books about paper. Eight of these have been produced on his own presses and his own handmade paper; some are printed by type he designed and made. At the Institute, Hunter will give a series of lectures and seminars on the History of Papermaking and will continue his researches and publications.

THIELE

Thiele Kaolin Co. has installed new spray-drying equipment at its Sandersville, Ga., plant. This new equipment is among the first of its type to be installed by the kaolin industry. Upon completion, and after testing, this Nerco-Niro (Nicholas Engineering & Research Corp.) spray drier will permit the offering to paper manufacturers and other users of kaolin, the latest improvements in drying water-washed hydrous aluminum silicates.

Wet and dry storage including pipeline and partially completed Nerco-Niro spray-dry unit at the Thiele Kaolin Co. plant at Sandersville, Ga.

During the past few years, Thiele have also made other additions to their facilities:

1. The installation of a dragline with 185-ft. boom and 6-yd. bucket, which provides for the clean stripping of overburden thereby sharply reducing the chance for external contamination. A constant source of supply is assured by the stockpiling of crude aluminum silicate. Crudes can be blended to give washer mill a uniform product.
2. Installation of new storage tanks and a 9-mile pipe line, from the mine to the plant, is further assurance of a dependable source of top-quality crude protected from possible transit contamination.

With the added benefits from this new spray-drying equipment, Thiele Kaolin Co. will be one of the most modern plants in the kaolin industry.

LINK-BELT

Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill., has published a bulletin (Link-Belt Book 2565A) describing a new line of "Mill Bearings," which now include pillow blocks with heavy duty self-aligning roller bearings for press fit on shafts.

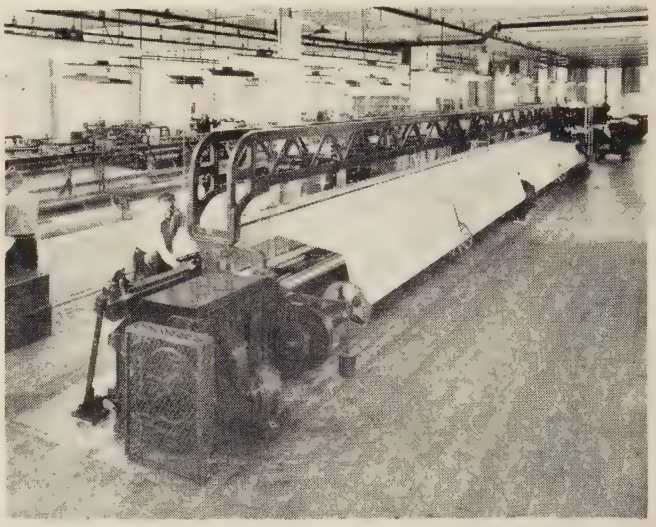
J-M

Johns-Manville, 22 E. 40th St., New York, N. Y., has published a technical bulletin on "How Flange Surface Finishes Affect Gasket Sealability and Joint Performance."

George S. Smith has been appointed director of engineering and a vice-president of the J-M Products Corp. succeeding C. B. Burnett, who has been promoted to other important executive responsibilities. Arthur C. Smith succeeds G. S. Smith as chief plant engineer in the General Engineering Department and Donald E. Hillier succeeds A. C. Smith as production engineer of the J-M Building Products Division.

ALBANY

Lewis R. Parker has been elected president of Albany Felt Co., Albany, N. Y. Frederick McDonald is now vice-chairman of the board.



Made by Crompton & Knowles and installed in the Albany Felt Co., Albany, N. Y., this 650-in. loom is the largest in the Western Hemisphere

Albany is now operating a 650-in. Crompton & Knowles loom, the largest in the western hemisphere.

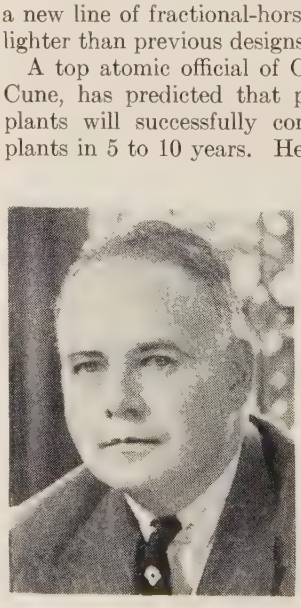
BECCO

H. O. Kauffmann has been appointed to the board of directors of Buffalo Electro-Chemical Co., Buffalo, N. Y. John F. Shea has been named secretary and treasurer.

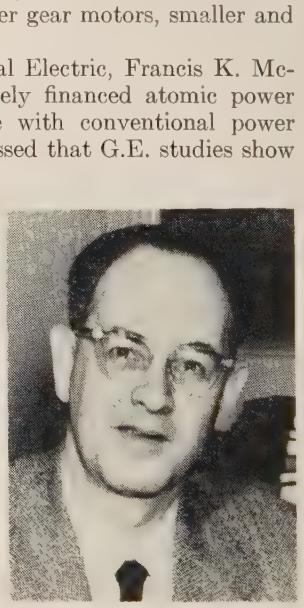
G.E.

General Electric Co., Schenectady 3, N. Y., has introduced a new line of fractional-horsepower gear motors, smaller and lighter than previous designs.

A top atomic official of General Electric, Francis K. McCune, has predicted that privately financed atomic power plants will successfully compete with conventional power plants in 5 to 10 years. He stressed that G.E. studies show



L. R. Parker, Albany Felt Co.



H. O. Kauffmann, Buffalo Electro-Chemical Co., Inc.

that production-size atomic power plants can be made to operate economically.

The light-water reactor is one which can become competitive in the higher fuel-cost areas of the country in the near future.

This reactor, according to G.E. studies, could produce electricity for 6.7 mils per kilowatt-hour, compared to a cost of 6.9 mils for a conventional coal burning plant. Plants chosen for comparison would each deliver 300,000 net kw. of electricity.

The cost figures described were derived on the basis of coal at $0.35 per million B.t.u., a price paid in a number of sections of this country.

McCune concluded his address by stating that General Electric feels that the time has arrived when we can look toward definite goals in the area of commercial atomic power —goals that can and will be achieved, and that almost inevitably will lead to expansion into a power age of great proportions with resultant benefits in human well-being.

FIBERGLAS

Owens-Corning Fiberglas Corp., Toledo, Ohio, has published a booklet on fiberglas low-pressure pipe insulation.

Fiberglas roof insulation, introduced less than 10 years ago, is today one of the most widely used built-up roof insulations

Fiberglas roof insulation is used over flat or low-pitched roof decks of any construction designed for built-up roofing. The insulation is made of inorganic, durable Fiberglas bonded with a stable resin. The top surface is coated with asphalt to which a strong kraft paper is bound to provide a good mopping surface and permit use of either asphalt or pitch in the built-up roofing. It is light weight and may be cut easily with a knife to fit around abutments

in the industry. Cited in its favor are thermal efficiency, light weight, fire safety, durability ,and economy of application.

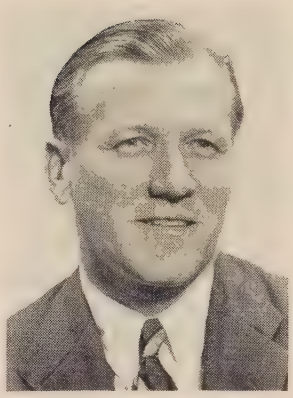
The Ruberoid Co., New York, N. Y., has been named a distributor of fiberglas roof insulation.

Richard W. Muzzy has been named to succeed George S. McElroy as manager of the Anderson, S. C., plant of Fiberglas. Mr. McElroy is now general factories manager of the textiles division. Edward J. Detgen and William M. Keller have been elected vice-presidents, and Mr. Keller is now general manager of the textiles division.

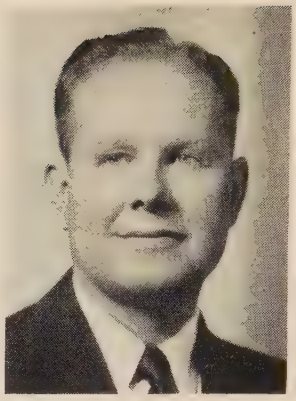
HERCULES

Expansion of the Hercules Powder Co.'s synthetic resins plant at Burlington, N. J., will be completed in the third quarter of 1954, and will double the plant output of Abitol, technical hydroabietyl alcohol.

Clifford S. Reppe has been appointed assistant district sales manager for the Hercules Paper Makers Chemical Dept. in Holyoke, Mass.



J. C. Barthel, American Cyanamid Co.



C. S. Reppe, Hercules Powder Co.

CYANAMID

J. C. Barthel has been appointed technical director of American Cyanamid Co.'s Paper Chemicals Dept., replacing Ralph W. Kumler, who retired recently.

M-C & S

An agreement under which Merritt-Chapman & Scott Corp. will offer to acquire a major interest in the Marion Power Shovel Co., Marion, Ohio, through an exchange of shares, has been ratified by the two companies.

Irving B. Purdy has been elected a vice-president of M-C & S., responsible for the Industrial and Building Construction Division.

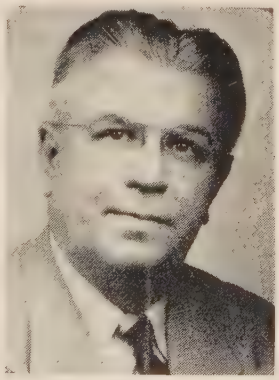
B-C

Frank T. Peterson has been named executive vice-president and chairman of the new executive policy committee of the Black-Clawson Co., New York, N. Y.

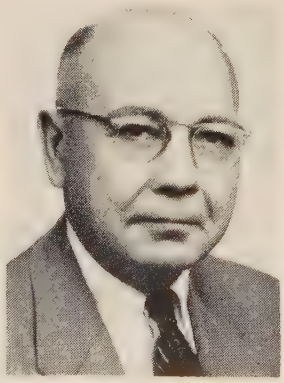
Robert F. Vokes, general manager of the Dilts Machine Works Division, Fulton, N. Y., has been elected a vice-president of B-C.

The appointment of Mr. Vokes is in line with company policies whereby the general managers of the three main American divisions of Black-Clawson serve in equal capacity as vice-president and general manager of their respective divisions. R. L. Kutter is vice-president and general manager of the Black-Clawson Hamilton, Ohio, Division, and O. W. Hein is vice-president and general manager of the Shartle Bros. Middletown, Ohio, Division.

Don H. Montville has been appointed sales manager of B-C's Shartle Bros. Machine Division, succeeding John A. Hamm, who will devote his activities almost exclusively to the promotion, engineering, and sales of several highly specialized items of pulp and paper mill equipment recently added to the



D. H. Montville, The Black-Clawson Co.



J. A. Hamm, The Black-Clawson Co.

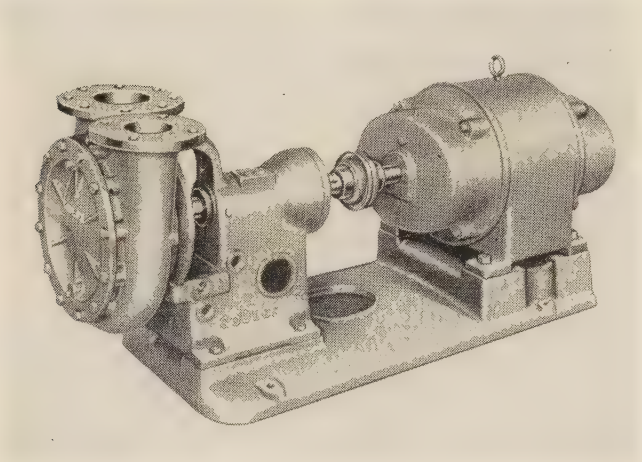
Shartle line of stock preparation equipment. Outstanding among these new items of equipment are the Strindlund tube-type filter and the new magnetic water clarification system which are applicable to both pulp and paper mill operation.

General Aniline

Sumner H. Williams has been elected vice-president and general sales manager of the Dyestuff and Chemical Division of General Aniline & Film Corp., New York, N. Y.

Goulds

Goulds Pumps, Inc., Seneca Falls, N. Y., is offering a new



The new Goulds Fig. 3715 support-head pump for handling corrosive liquids and slurries. Cooling of support head and quenching of gland make it possible to handle liquids up to 350°F.

line of centrifugal pumps, designated Fig. 3715, designed for handling corrosive liquids and slurries.

Delrac

Delrac Corp., Watertown, N. Y., has published a folder (Bulletin 500) describing its corrosion-resistant mortars. Delrac polyester cement is stated to be particularly useful for chlorine dioxide applications.

Standard Oil (Ind.)

J. W. Ross has been appointed assistant general manager-at-large, W. H. Miller, assistant general manager—sales promotion and advertising, J. M. Hamer, assistant general manager—administrative, J. M. Lamoreaux, assistant general manager—gasoline and fuel oils, and G. T. Dougherty, assistant general manager—industrial sales and technical service, of the Standard Oil Co.'s sales department. Regional sales managers are as follows: central region, C. E. Quinn, Chicago; eastern region, A. V. Fraser, Detroit; northern region, C. H. Coughlin, Milwaukee; northwestern region, W. C. Kniefel, Minneapolis; southern region, M. I. Hector, St. Louis; southeastern region, H. J. Kaufman, Indianapolis; southwestern region, H. E. Purdy, Kansas City; western region, C. C. Ingelfield, Des Moines; and Rocky Mountain region, H. E. Prunty, Denver.

National Lead

National Lead Co., New York, N. Y., has begun construction of new facilities for the production of titanium dioxide at St. Louis, Mo. The additional capacity, about 36,000 tons a year as TiO_2, will be added on top of expansions three years ago at both the Sayreville, N. J., and St. Louis titanium pigment plants of the company. It is expected that the new production will begin in July of 1955, with the new facilities in full operation by the end of the year.

Glidden

John R. Garrason has been appointed vice-president and sales manager of E. W. Colledge, G.S.A., Inc., a subsidiary of the Glidden Co., Cleveland, Ohio. Robert F. Colyer has rejoined Colledge's sales staff.

Nopco

Yocum Faust, Ltd., a wholly owned subsidiary of Nopco Chemical Co. of Harrison, N. J., has awarded to a large Canadian construction company a contract for an additional manufacturing unit to be erected on their land at the London, Ontario, plant.

Carborundum

The Carborundum Metals Co., Akron, N. Y., has published a compilation of "Facts About Zirconium."

Foxboro

The Foxboro Co., Foxboro, Mass., has published a bulletin (5c-13) describing needle control valves for low rates of flow.

Diamond

Diamond Power Specialty Corp., Lancaster, Ohio, has issued a bulletin (No. 1175) describing the new Diamond UtiliVue closed circuit television, which is being distributed by Graybar Electric Co.

Hooker

Following are design features of the new Hooker Electrochemical Co. plant which opened recently at Montague, Mich.

Design: Co-designed by Hooker engineers and H. K. Ferguson Co., Cleveland, Ohio.
Construction: By H. K. Ferguson Co. Construction was begun in August, 1952. Started operation of plant on March 17, 1954.
Cost of Plant: Over $12,000,000.
Acreage: 650 acres with several other properties under option.
Employees: As of June 1, 1954, 101 at Montague, 2301 total at all plants.
Location: In Montague Township, a Summer resort area located on White Lake. 14 miles north of Muskegon, 60 miles northwest of Grand Rapids. About 130 miles by water and 208 rail miles northeast of Chicago.
Products: Caustic soda, chlorine, hydrogen.
Rated Capacity When Planned Cell Installations Are Completed: 153 tons of caustic soda, 140 tons of chlorine and 1,422,000 cu. ft. of hydrogen per day.
Markets: Within 500 mile radius lies 40% of the nation's people and 50% of its industry.

Aerial view of the Hooker Electrochemical Co. plant at Montague, Mich.

Method of Manufacture: Passing direct current through brine in Hooker Type S-3A electrolytic cells.
Buildings: Eight major buildings plus several buildings such as the guest house and recreation hall which were part of the original purchase.
Total Floor Space: 124,000 sq. ft.
Steel: 2000 tons of structural steel, 300 tons of reinforcing steel.
Concrete: 16,000 cu. yd.
Pipings: 20 miles of process piping and 8 miles of utility piping.
Water Pumping Capacity: Pump house at White Lake contains two pumps—total capacity of 20 million gallons of water per day. In addition, two water wells at brine field and one in the plant area supply substantial amounts of water to make brine and for the potable water supply.
Concrete-lined Equalizing Pond for Effluent Control: Eight million gallons capacity, 300 by 400 ft.—the size of almost three football fields placed side by side. The water is 10–12 ft. deep. Contains the equivalent of one day's effluent. Water passes over a weir extending the full length of the pond and leaves the pond from two discharge points on the opposite side.
Salt Supply: Located in the saline salt formation of Western Michigan. 200 acres are set aside as a brine field. The salt is exceptionally pure and is estimated at one million tons to the acre. 200 million tons of salt should last the company many hundreds of years. The salt is in two layers averaging a total of 430 ft. in thickness. The three brine wells extend to 3582 ft. below the surface of the ground.
Boiler House: Two boilers—combined capacity of 200,000 lb. of steam per hour.
Coal Handling: Capacity 150 tons per hour. Coal can be discharged from cars directly to bunkers in the boiler house or to stock pile.
Smokestack: 225 ft. high, containing 170,000 bricks.
Sewage Disposal Plant: Operate own plant with substantial extra capacity.
Electric Power Input System: Could light a city of 100,000 people.
Automatic Control Devices: Over 300.
Railroad: A two-mile spur was built to the plant by the C & O Railroad.
Dockage Facilities: Built to accommodate large barges for caustic soda and for possible incoming raw materials. On June 2, 1954, the first barge shipment of caustic was made from Montague to Hooker's million gallon bulk storage tank at Lake River Terminal, Chicago, for distribution from that point. This 400,000-gallon shipment was the first time in 60 years that cargo had been shipped by boat from White Lake—since the lumbering operations of the last century.

Hooker Electrochemical Co., celebrating its 50th anniversary in 1955, now has three plants—the headquarters and main plant at Niagara Falls, N. Y., and plants at Tacoma, Wash., and Montague, Mich. Hooker manufactures about 100 chemicals. Sales currently range over $40,000,000 per year. In addition, Hooker has joint ownership with Detrex Corp. in Hooker-Detrex Co., operating plants at Tacoma, Wash., and Ashtabula, Ohio, for the manufacture of trichloroethylene.

The following additions have been made recently to Hookers technical staff: Kenneth O. Hambrock, Francis B. Antonou, Edwin R. Ewaszczak, Dorothy J. Pohlman, and Joyce C. Wilkinson.

Louis Allis

The Louis Allis Co., Milwaukee 7, Wis., has published a bulletin (No. 1550) describing its new integral Brakemotor.

Lockport and Orr

Lockport Felt Co., Newfane, N. Y., and Orr Felt and Blanket Co., Piqua, Ohio, have contracted jointly with Downingtown Mfg. Co., Downingtown, Pa., for the design and manufacture of four new felt driers and stretchers, two to be delivered to each felt company.

Cleaver-Brooks

Harold R. White Co., Baltimore, Md., has been appointed manufacturer's representative for the sale of Cleaver-Brooks boiler equipment.

Hygrotester

Hygrotester, Inc. is temporarily located at the Hotel St. George, Clark and Henry Sts., Brooklyn, N. Y., its previous office having been burned out recently. Hygrotester's mail address remains unchanged: P.O. Box 923, Brooklyn 1, N. Y.

Pennsalt

Vance N. Wilson has been appointed manager of the new Pennsylvania Salt Mfg. Co. plant at Chicago Heights, Ill. Robert W. Clarke has been named manager of Pennsalt's new plant at Delaware, Ohio.

Graver

Graver Water Conditioning Co., 216 W. 14th St., New York, N. Y., is offering a graphic panel arrangement for all automatic ion exchange equipment, which allows the operator to see at a glance if the system is functioning properly.

B & W

Ralph K. Behr has been appointed manager of the Boston district office of the Babcock & Wilcox Co.'s Boiler Division, replacing H. K. Dean, who has retired after 31 years of service with the company.

Permutit

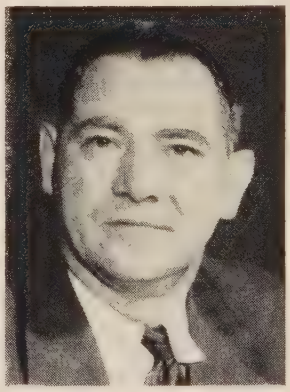
Robert Fay O'Connell has been appointed sales engineer in the St. Louis, Mo., office of the Permutit Co., New York, N. Y. John P. Termini has joined Permutit's Special Applications Department.

Carpenter

John H. Pettit, Gardenvale, Quebec, has been appointed sales agent in eastern Canada for the Alloy Tube Division of the Carpenter Steel Co., Union, N. J.

Downingtown

Frank C. Arnold has joined the Downingtown Mfg. Co., Downingtown, Pa., as sales engineer for paper finishing machinery.



Frank C. Arnold, Downingtown Mfg. Co.

Ross Midwest-Fulton

J. O. Ross Engineering Corp. has purchased the Midwest-Fulton Machine Co., Dayton, Ohio, and a new firm, Ross Midwest-Fulton Corp., Dayton, Ohio, has been organized to handle the Midwest-Fulton business. Executives of the new corporation are as follows: S. W. Fletcher, president; J. F. Gschwind, vice-president and manager; W. V. Knoll, vice-president; J. F. Forsyth, treasurer; W. K. Metcalfe, secretary; G. J. Jacobs, assistant secretary. Robert M. Cook, for many years chief engineer, will continue in that capacity and in addition becomes vice-president, and Hugh P. Quinn and Albert J. Smith have been named service manager and sales engineer, respectively.

The company will be represented in Canada by Ross Engineering of Canada, Ltd., with offices in Montreal, Toronto, Port Arthur, and Vancouver.

F & P

Fischer & Porter Co., Hatboro, Pa., has published the following catalogs: No. 53-10, Pneumatic Controllers, No. 70-50 Chemical Feeder, No. 70-20, Automatic Proportioner for F & P Chlorinator. F & P has established a Data Reduction

and Automation Division to handle the data reduction systems of the recently acquired Electrical Development Co. and the Digi-Coder Corp.

Graton & Knight

The Graton & Knight Co., Worcester, Mass., has opened a new Detroit branch office at 16146 Wyoming St., Detroit, Mich. Robert C. Kerr is manager of the new office, which will also serve as a branch office for International Packings Corp., Bristol, N. H., a Graton & Knight subsidiary.

Gurley

W. & L. E. Gurley, Troy, N. Y., has issued a bulletin (No. 1400) describing its new high-pressure smoothness tester.

Raybestos-Manhattan

Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J., has published a catalog (No. 25-c) describing its rubber products for industry.

Cowles

Horton Meyer has been elected vice-president and general manager of the Cowles Co., Cayuga, N. Y.

Betz

B. F. Shema, formerly with The Institute of Paper Chemistry, has joined the staff of W. H. & L. D. Betz, Philadelphia, Pa.

Foster D. Snell

Ralph W. Kumler, formerly with American Cyanamid Co., has joined the staff of Foster D. Snell, Inc., New York, N. Y., as a pulp and paper consultant.

Crane Co.

The following facts regarding the Crane Co. are taken from a fact sheet for the company's centennial, which will be celebrated in 1955.

History. Richard Teller Crane, founder of the Crane Co., came to Chicago in May, 1855, and opened his own little foundry in a one-room frame building that he built himself on the corner of his uncle's lumber yard. Opening day, significantly, was July 4, 1855. A sign on the building proclaimed it to be the "R. T. Crane Brass and Bell Foundry." R. T. Crane was born May 15, 1832, in Paterson, N. J., and died Jan. 8, 1912, in Chicago.

Early history of Crane, including changes in the corporate name, are recorded in detail in various publications on file at the present offices of Crane Co. in Chicago. These publications include: an autobiography of the founder, Richard Teller Crane; "An Old Man Looks Back," reminiscences of John B. Berryman, fourth president of Crane Co.; complete files of "Valve World," and "Crane World," Crane Co. publications; early sales manuals and other publications.

Crane Co.'s rise from humble beginnings a century ago to a multi-million dollar corporation with sales of more than 315 million dollars last year is typical of American industry that has grown and prospered as it continued year after year to improve its service to mankind.

R. T. Crane operated the company as sole proprietor from July 4, 1855, until Feb. 15, 1865, when it was incorporated as Northwestern Manufacturing Co. The name was changed on Aug. 19, 1872, to Crane Brothers Manufacturing Co. in honor of R. T. Crane's brother, Charles, whose interest in the company R. T. Crane purchased on that date. On Feb. 1, 1890, the name was changed to the present version, Crane Co. The word "company" is never spelled out.

Wide Range of Products. R. T. Crane's first castings were tips and couplings for lightning rods. Today, Crane Co.'s products range from gate valves as big as a door to electronic transitors no larger than a thumb nail. Bathroom and kitchen fixtures and plumbing are the products most often seen by the public, yet the majority of the Crane Co.'s sales are of valves, pipe fittings, and jobbed pipe to industry.

R. T. Crane established the first pipe mill west of Pittsburgh in 1864, and established the first malleable iron foundry west of Pittsburgh in 1865. Crane Co. no longer makes pipe, but still jobs it. Crane Co. has stayed in the valve and pipe fittings and pipe fabrication business persistently almost from the first. Other lines have been taken up by the company and dropped, but the manufacture of valves and fittings has remained the principal business. Other lines manufactured by the company in the past have included such things as pipe itself, freight and passenger elevators, railroad air brakes systems, journal boxes for freight cars, metal trim for steam engines, and various types of engines.

At present, Crane Co. is engaged in the manufacture and distribution of valves, fittings, fabricated piping and piping accessories, plumbing fixtures, plumbing brass trim, heating equipment, kitchen cabinets, and accessory equipment for aircraft.

In the order of dollar sales volume, the principal classifications of industrial products manufactured by Crane Co. are: valves, fittings, fabricated piping, and accessories.

Crane Co. is the largest producer of valves and fittings in the world. The standard product line includes numerous types and sizes of valves, fittings, and appliances for the control and conveyance of oil, water, and other liquids, steam, air, and gases.

Industrial products manufactured by Crane Co. are made of ferrous and nonferrous materials, including brass, copper, malleable and cast iron and forged and cast steel for use under various pressures and temperatures and to resist the action of many kinds of chemicals.

Industrial products of Crane Co. are used in construction and maintenance activities and in practically all industries including: pulp and paper, oil and gas, petrochemical, public utilities, railroads, ship building, steel, chemical, machinery, construction, food products, plastics, rubber, and others.

Basic Materials Used. Principal basic materials used by Crane Co. and its subsidiaries in the operation of the steel, iron, and nonferrous foundries are pig iron, steel and iron scrap, brass ingots, alloying metals, coke, and other foundry materials.

Crane Co. buys steel mill products, including pipe, billets, rod and bar steel; brass mill products, including rod pipe and tubing; and other materials, including zinc, monel, and plating materials.

Clay, flint, spar, and glazing and enameling materials also are used in the production of plumbing fixtures.

The manufacture and sale of valves, fittings, fabricated piping, and accessories to industry constitute the most important part of Crane Co.'s business, accounting for approximately 65% of the sales of products manufactured by the company.

Westinghouse

A new multimillion dollar sound laboratory and test center for transformers will be built at Westinghouse Electric Corp.'s Transformer Division plant in Sharon, Pa. The new transformer "indoor proving ground" will be ready for operation by early next year.

To be erected in a 200-ft.-long extension of four existing assembly aisles at the big Sharon plant, the test center will offer something new in industrial operations. Every one of the big power transformers that is manufactured will be carried by overhead crane into the test center and undergo a series of searching examinations and electrical tests before it is shipped to the customer.

At one point, the transformer can be bombarded by 5 million volts and 275,000 amperes worth of man-made lightning. Only a few feet away from this thunderous noise will be one of the quietest spots in the world—a building erected inside the over-all test building and housing an ultramodern sound laboratory.

The sound laboratory will be 70 ft. long, 56 ft. wide, and 55 ft. high. It will be constructed so that it will be virtually impossible for sound to enter or to leave the laboratory. The floor will be concrete 3 ft. thick. The 5-ft.-thick walls will be made of concrete, several inches of air space, and fiberglas. On the inside, the walls will be covered with fiberglas wedges and wire mesh—egg crate style—to prevent reflection of sound.

Within the walls of the sound laboratory will be metallic shielding to prevent even radio waves from entering the lab and interfering with tests. A well-insulated sliding door of steel and concrete will separate the sound lab from the outside world, and from the indoor test center itself.

The soundproof room will be large enough to test transformers weighing up to 400 tons and rated at greater than 500,000 kva., much more powerful and larger than any transformers now being manufactured. These sound tests assure that the powerful transformers will operate as silently as possible.

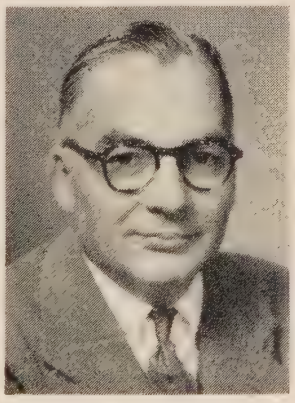
The over-all building for the test center has been designed by Prack and Prack of Pittsburgh and the sound laboratory by Commonwealth Associates of Jackson, Mich.

OBITUARIES

W. H. Graebner

Winfred Henry Graebner, production manager of the Marathon Corp., Menasha, Wis., died in July.

Mr. Graebner was born in Milwaukee, Wis., On Oct. 2, 1904, and studied chemistry at Lawrence College and the University of Wisconsin. His entire professional career was spent with the Marathon Corp., joining the company in 1927 as a chemist at its Rothschild pulp and paper mill. In 1931 he was transferred to Menasha as manager of the technical department. After working in several production capacities, he became chief mill manager in 1952 and was named pulp and paper mill production manager a year ago.



W. H. Graebner

During World War II he was a member of the War Production Board for a year as chief of military packaging and received a merit award from the United States Quartermaster Corps.

Mr. Graebner became a member of the Technical Association of the Pulp and Paper Industry in 1928.

Robert T. Vanderbilt

Robert T. Vanderbilt, 69, President of the R. T. Vanderbilt Co., New York, N. Y., died in Bellevue Hospital, New York City, on August 14th from injuries suffered on August 13 when he was struck by a truck as he was crossing Lexington Avenue at 43rd Street on his way to the Cloud Club in the Chrysler Building to dine with friends.

Mr. Vanderbilt had homes at 740 Park Avenue, New York City, and at Green Farms, Conn. In 1916 he founded the R. T. Vanderbilt Co., a company member of the Technical Association of the Pulp and Paper Industry.

His wife, Mrs. Mildred Bedford Vanderbilt, died in 1950. Surviving are three sons, Frederick B., Robert T., Jr., and Hugh Vanderbilt, and one sister, Mrs. Robert Hodgson.

George F. Hrubecky

George Francis Hrubecky, manager of central plant engineering for the Marathon Corp., Menasha, Wis., died in July of a heart attack.

Mr. Hrubecky was born in Neenah, Wis., on Feb. 11, 1903, and graduated as a chemical engineer in 1927 from the University of Wisconsin.

From 1920 to 1924 he was a laboratory assistant for the Menasha Printing & Carton Co., Menasha, Wis. In 1924 and 1925 he was laboratory supervisor for Peshtigo Pulp & Paper Co., Peshtigo, Wis. From 1927 to 1947 he was engineer and general superintendent for the John Strange Paper Co., Neenah, Wis. He started in 1947 as a maintenance engineer in the engineering section of the Marathon Corp. A year later he became manager of central plant engineering.

George F. Hrubecky

At the Eighth Engineering Conference of the Technical Association of the Pulp and Paper Industry held at Montreal, Que., in October, 1953, Mr. Hrubecky was appointed chairman of the TAPPI Mill Maintenance and Materials Committee.

Carlo Vicario

Carlo Vicario, former partner of the firm of Clark & Vicario, Bronxville, N. Y., died as the result of an accident in San Francisco, Calif., on July 27, 1954.

Mr. Vicario was born in New York City on Jan. 17, 1902 and graduated as an electrical engineer from the Massachusetts Institute of Technology in 1924.

Prior to forming the Clark & Vicario firm in 1945 with Carl Clark, he was associated for 19 years with the Pulp and Paper Division of the Nash Engineering Co., South Norwalk, Conn., as manager.

In Janary, 1952, he retired from the partnership of Clark & Vicario and traveled extensively, residing in Italy for over a year. Upon his return to the States, he went to San Francisco as a consultant for a building contractor.

Mr. Vicario became a member of the Technical Association of the Pulp and Paper Industry in 1931.

Richard T. Anderson

Richard T. Anderson, vice-president of the Paterson Parchment Paper Co., Bristol, Pa., died at his home in Lawrenceville, N. J., on Aug. 9, 1954. He was 75 years of age.

Mr. Anderson was born in Passaic, N. J., and graduated from the Stevens Institute of Technology. He joined the Paterson firm in 1919 as a plant engineer. In 1932 he was appointed general manager and became vice-president in 1945.

For several years Mr. Anderson was the official corporate representative of his company in the Technical Association of the Pulp and Paper Industry.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Officers of Local Sections

The Local Sections of the Technical Association will start their new series of meetings this month, September, and will continue to hold them until next June. The annual meetings of the Sections are usually held during May or June at which time the officers for the next season are elected. The officers and executive committeemen, who were elected for the 1954–55 terms, are as follows:

Pacific

Chairman—E. H. Nunn, Crown Zellerbach Corp., West Linn, Ore.
Vice-Chairman—J. M. McEwen, Weyerhaeuser Timber Co., Everett, Wash.
Secretary-Treasurer—H. B. Petersen, Hercules Powder Co., Portland, Ore.
Executive Committee—Officers and John L. Ayres, E. I. du Pont de Nemours & Co., Inc., Portland, Ore.; B. T. Briggs, Rayonier, Inc., Shelton, Wash.; F. R. Hamilton, Everett Pulp & Paper Co., Everett, Wash.
Past-Chairmen—C. R. P. Cash, R. S. Wertheimer, C. W. Morden, R. B. Hansen, Lawrence Killam, M. W. Black, W. R. Barber, F. A. Olmsted, Carl Fahlstrom, G. H. McGregor, N. W. Coster, C. E. Braun, E. P. Wood, C. A. Enghouse, Erik Ekholm, H. W. Bialkowsky, G. H. Gallaway, J. L. McCarthy, H. C. Wall, W. F. Holzer, R. I. Thieme, E. O. Ericsson, S. E. Hazelquist, and F. J. Weleber.
National Executive Committee Representative—R. I. Thieme, Scott Paper Co., Anacortes, Wash.

Lake States

Chairman—L. A. Moss, Whiting-Plover Paper Co., Stevens Point, Wis.
Vice-Chairman—S. R. Parsons, Consolidated Water Power & & Paper Co., Wisconsin Rapids, Wis.
Secretary—John W. Bard, Marathon Corp., Menasha, Wis.
Treasurer—S. J. Baisch, Thilmany Pulp & Paper Co., Kaukauna, Wis.
Executive Committee—Officers and K. A. Craig, Kimberly-Clark Corp., Neenah, Wis.; Fred Herbolzheimer, Jr., Marinette Paper Co., Marinette, Wis.; J. M. Holderby, Rhinelander Paper Co., Rhinelander, Wis.; and J. A. Van den Akker, The Institute of Paper Chemistry, Appleton, Wis.
Past-Chairmen—G. K. Hill, Otto Kress, R. J. LeRoux, A. T. Gardner, S. D. Wells, J. R. Fanselow, H. W. Morgan, E. H. Voightman, R. A. Nugent, M. L. Downs, N. L. Malcove, J. H. Graff, T. R. Probst, J. P. Weidner, H. P. Dixson, L. V. Forman, C. J. West, Jr., A. M. Heald, G. R. Sears, H. C. Crandall, A. P. Adrian, H. W. Rowe, and R. J. Seidl.
National Executive Committee Representative—H. F. Lewis, the Institute of Paper Chemistry, Appleton, Wis.

Delaware Valley

Chairman—E. R. Padavic, Container Corp. of America, Manayunk, Pa.
First Vice-Chairman—E. C. Molin, Westfield Paper Co., West Conshohocken, Pa.
Second Vice-Chairman—P. E. Nethercut, Scott Paper Co., Chester, Pa.
Treasurer—C. R. Calkins, Riegel Paper Corp., Milford, N. J.
Secretary—C. F. Ackerman, Union Mills Paper Mfg. Co., New Hope, Pa.
Executive Committee—Officers and F. J. Lovegren, P. H. Glatfelter Co., Spring Grove, Pa., and H. C. Brill, E. I. du Pont de Nemours Co., Inc., Newport, Del.
Past-Chairmen—W. R. Maull, G. E. Landt, H. P. Cannon, H. C. Schwalbe, J. d'A. Clark, C. M. Conner, E. J. Albert, J. D. Davis, W. M. Shoemaker, A. L. M. Bixler, John Macadam, J. P. Weidner, A. S. Erspamer, H. C. Brill, and F. J. Lovegren.
National Executive Committee Representative—W. D. Harrison, Riegel Paper Corp., Milford, N. J.

Kalamazoo Valley

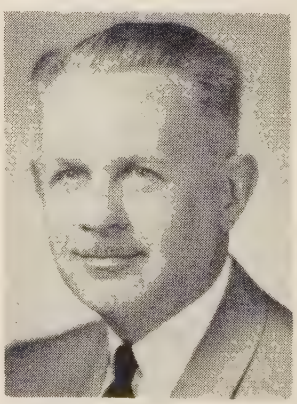
Chairman—J. A. Dean, Michigan Paper Co., Plainwell, Mich.
Vice-Chairman—R. T. Trelfa, Watervliet Paper Co., Watervliet, Mich.
Secretary—R. T. Elias, Western Michigan College, Kalamazoo, Mich.
Treasurer—L. A. Pierce, St. Regis Paper Co., Kalamazoo, Mich.
Executive Committee—Officers and W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.; C. E. Mueller, Lockport Felt Co., Kalamazoo, Mich.; J. A. Wise, Kalamazoo Paper Co., Kalamazoo, Mich.; and R. H. Hurst, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
Past-Chairmen—M. D. Bardeen, E. F. Whittington, H. C. Bradford, C. C. Schneider, H. M. Annis, M. R. Wilkins, W. F. Hathaway, P. de Guehery, W. A. Kirkpatrick, F. L. Chappell, F. D. Elliott, F. R. Hamilton, E. B. Taylor, R. C. Germanson, R. T. Mashburn, L. H. Mimms, P. W. Bartholomew, S. I. Kukolich, J. J. Harrison, J. R. Dam, A. T. Luey, and R. H. Hurst.
National Executive Committee Representative—R. L. Davis, Detroit Sulphite Pulp & Paper Co., Detroit, Mich.

New England

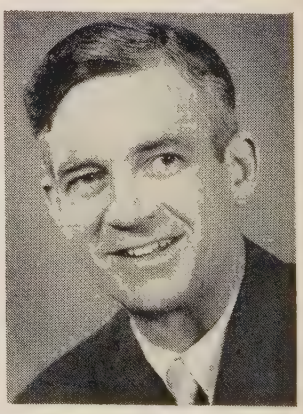
Chairman—F. S. Klein, Byron Weston Co., Dalton, Mass.
Vice-Chairman—G. L. Benson, St. Regis Paper Co., East Pepperell, Mass.
Secretary-Treasurer—R. W. Ramsdell, Hercules Powder Co., Holyoke, Mass.
Executive Committee—Officers and Miss Helen U. Kiely, Northampton, Mass.; F. L. Simons, Crane & Co., Dalton, Mass.; P. L. Haggerty, Geo. Lamonte & Son, Nutley, N. J.; J. T. Loomer, Robert Gair Co., Inc., Uncasville, Conn.; C. L. Reece, Whiting Paper Co., Holyoke, Mass.; C. I. Horton, Norwalk, Conn.; Freeman Perry, Chemical Paper Mfg. Co., Holyoke, Mass.; and George Wallace, III, Fitchburg Paper Co., Fitchburg, Mass.
Past-Chairman—F. C. Clark, R. C. Griffin, J. B. Calkin, R. H. Doughty, N. I. Bearse, W. L. Foote, L. B. Tucker, C. H. Child, P. S. Bolton, R. J. Proctor, and H. W. Knudson.
National Executive Committee Representative—N. I. Bearse, Champion-International Co., Lawrence, Mass.

Ohio

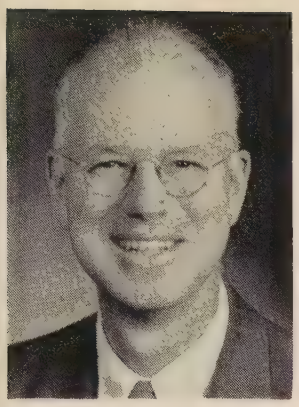
Chairman—H. R. Joiner, Champion Paper & Fibre Co., Hamilton, Ohio.
Vice-Chairman—W. H. Aiken, Gardner Board & Carton Co., Middletown, Ohio.
Corresponding Secretary—D. F. Jenkins, Champion Paper & Fibre Co., Hamilton, Ohio.
Recording Secretary—E. W. Petrich, Aetna Paper Co. Div., Howard Paper Mills, Inc., Dayton, Ohio.



E. H. Nunn, Crown Zellerbach Corp.; Chairman, Pacific Section



L. A. Moss, Whiting-Plover Paper Co., Chairman, Lake States Section



J. A. Dean, Michigan Paper Co.; Chairman, Kalamazoo Valley Section

F. S. Klein, Byron-Weston Co.; Chairman, New England Section

Treasurer—G. B. Gregg, Cincinnati Gas & Electric Co., Cincinnati, Ohio.
Executive Committee—Officers and J. L. Clouse, Oxford-Miami Paper Co., West Carrollton, Ohio; C. E. Brandon, Howard Paper Mills, Inc., Dayton, Ohio; H. A. Smith, The Mead Corp., Chillicothe, Ohio; D. J. Goodman, Sorg Paper Co., Middletown, Ohio; and John Nolan, Sorg Paper Co., Middletown, Ohio.
Past-Chairmen—V. F. Waters, H. H. Latimer, K. P. Geohegan, J. E. Burdsell, H. C. Fisher, C. D. Roess, S. I. Olsen, D. M. Yost, P. S. Cade, Arthur Thurn, D. J. Goodman, H. A. Smith, C. E. Brandon, and J. L. Clouse.
National Executive Committee Representative—G. H. Pringle, The Mead Corp., Chillicothe, Ohio.

Empire State

Chairman—F. G. Sommerville, Armstrong Cork Co., Fulton, N. Y.
First Vice-Chairman—W. R. Willets, Titanium Pigment Corp., New York, N. Y.
Second Vice-Chairman—G. K. Storin, Niagara Alkali Co., Niagara Falls, N. Y.
Third Vice-Chairman—R. H. Wilse, International Paper Co., Glens Falls, N. Y.
Secretary-Treasurer—R. N. Prince, Eastern Chemicals, Inc., Albany, N. Y.
Executive Committee—Officers and G. C. Cole, Diamond Match Co., Plattsburg, N. Y.; J. J. Forsythe, International Paper Co., Niagara Falls, N. Y.; D. C. Mather, Carthage Paper Makers, Inc., Carthage, N. Y.; F. W. O'Neil, State University of New York, College of Forestry, Syracuse, N. Y.; J. C. Rice, Lowe Paper Co., Ridgefield, N. J.; H. A. Spencer, Knowlton Brothers, Inc., Watertown, N. Y.; and S. J. Young, Crown Zellerbach Corp., Carthage, N. Y.
Past-Chairmen—J. H. Schuber, C. E. Libby, J. H. Rich, R. F. Huntley, F. C. Goodwill, H. D. Cook, F. J. Lang, W. O. Hisey, F. J. McCourt, H. A. Spencer, John Campbell, M. L. Jaffe, J. E. Foote, C. E. Foster, H. J. Perry, J. S. Reichert, R. M. Drummond, and D. C. Mather.
National Executive Committee Representative—C. J. Sibler, West Virginia Pulp & Paper Co., New York, N. Y.

Central District

Chairman—F. W. O'Neil, State University of New York, College of Forestry, Syracuse, N. Y.
Chairman-Elect—D. W. Geffken, Oswego Falls Corp., Fulton, N. Y.
Secretary—R. G. Hitchings, State University of New York, College of Forestry, Syracuse, N. Y.
Treasurer—S. E. Church, University of New York, College of Forestry, Syracuse, N. Y.

Eastern District

Chairman—G. C. Cole, The Diamond Match Co., Plattsburg, N. Y.
Vice-Chairman—E. H. Johnson, Stevens & Thompson Paper Co., Greenwich, N. Y.
Secretary—R. J. Collins, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.
Treasurer—Clyde Davis, Jr., Finch, Pruyn & Co., Inc., Glens Falls, N. Y.

Metropolitan District

Chairman—J. C. Rice, Lowe Paper Co., Ridgefield, N. J.
Chairman-Elect—L. R. Ayers, Robert Gair Co., Piermont, N. Y.
Secretary-Treasurer—J. H. Doherty, Union Bag & Paper Corp., New York, N. Y.

Northern District

Chairman—S. J. Young, Crown Zellerbach Corp., Carthage, N. Y.
Vice-Chairman—R. A. Schwartz, Knowlton Brothers, Inc., Watertown, N. Y.
Secretary—E. L. Case, G. D. Jennsen Co., Watertown, N. Y.
Treasurer—P. R. Anderson, St. Regis Paper Co., Deferiet, N. Y.

Western District

Chairman—J. J. Forsythe, International Paper Co., Niagara Falls, N. Y.
Vice-Chairman—R. H. Zinsmeister, Kimberly-Clark Corp., Niagara Falls, N. Y.
Secretary—H. E. Lindberg, Robert Gair Co., Tonawanda, N. Y.
Treasurer—E. F. Andrews, International Paper Co., Niagara Falls, N. Y.

Maine-New Hampshire

Chairman—A. E. Jones, Oxford Paper Co., Rumford, Me.
Vice-Chairman—F. N. Sprague, St. Regis Paper Co., Bucksport, Me.
Secretary-Treasurer—H. E. Pratt, Pejepscot Paper Div., Brunswick, Me.
Executive Committee—J. F. Wright, National Aniline Div., Boston, Mass.; A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.; C. T. Backus, Eastern Corp., Bangor, Me.; Roland Martin, Fraser Co., Madawaska, Me.; H. S. Hooper, Penobscot Chemical Fiber Co., Great Works, Me.; J. H. Heuer, Great Northern Paper Co., Millinocket, Me.; J. J. Thomas, S. D. Warren Co., Cumberland Mills, Me.; W. L. Hinds, Keyes Fiber Co., Waterville, Me.; A. J. Chase, University of Maine, Orono, Me.; and E. N. Poor, Hudson Pulp & Paper Corp., Augusta, Me.
Past-Chairmen—W. E. Brawn, T. M. Barry, Clifford Patch, E. L. Lamb, J. L. Parsons, G. A. Day, and Joseph J. Thomas.
National Executive Committee Representative—George A. Day, Brown Co., Berlin, N. H.

Chicago

Chairman—J. D. Johnson, Container Corp. of America, Chicago, Ill.
Vice-Chairman—A. C. Dreshfield, Chicago Testing Laboratories, Chicago, Ill.
Secretary—J. R. Lyon, Atlas-Boxmakers, Inc., Chicago, Ill.
Treasurer—R. D. Carter, Keyes Fiber Sales Corp., Hammond, Ind.
Executive Committee—Officers.
Past-Chairmen—H. R. Alley, H. E. Weston, F. D. Long, J. L. Kubicka, W. R. Price, G. A. Zinkel, A. K. Roach, V. V. Vallandigham, and E. C. Berg.
Executive Committee Representative—F. D. Long, Container Corp. of America, Chicago, Ill.

Lake Erie

Chairman—Lloyd Shand, Monsanto Chemical Co., Cleveland, Ohio.
First Vice-Chairman—M. A. Veigel, National Aluminate Co., Cleveland, Ohio.
Second Vice-Chairman—Theodore Welles, Moser Bag & Paper Co., Cleveland, Ohio.
Treasurer—R. C. Matthews, Chase Bag Co., Chagrin Falls, Ohio.
Secretary—J. F. Richmond, Ace Electrotype Co., Cleveland, Ohio.
Financial Secretary—S. B. Gulliford, Gulliford Printing Co., Cleveland, Ohio.
Executive Committee—R. L. Lewis, The Ohio Boxboard Co., Rittman, Ohio; John Walton, National Container Co., Jaite, Ohio; John Preston, Federal Adhesives Corp., Cleveland, Ohio; Leo Gebo, The Thomas Phillips Co., Akron, Ohio; Charles Daggett, Corn Products Sales Co., Cleveland, Ohio; C. A. Markee, The Ohio Boxboard Co., Rittman, Ohio; William Schoenberg, Lord and Schoenberg, Cleveland, Ohio and Richard Ihde, Dairy Pak Products, Cleveland, Ohio.
Past-Chairmen—L. K. Burnett, William Schoenberg, William Hasselo, and R. L. Lewis.
National Executive Committee Representative—L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio.

Southeastern

Chairman—M. B. Pineo, Brunswick Pulp & Paper Co., Brunswick, Ga.

Vice-Chairman—C. N. Rogers, Sonoco Products Co., Hartsville, S. C.
Corresponding Secretary—R. A. Flick, Brunswick Pulp & Paper Co., Brunswick, Ga.
Recording Secretary—C. L. Smith, National Container Corp., Jacksonville, Fla.
Treasurer—G. E. Scofield, Rayonier, Inc., Fernandina, Fla.
Past-Chairman—G. C. Kimble.
Executive Committee—Officers and G. C. Kimble and J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga.
National Executive Committee Representative—J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga.

Papermakers and Associates of Southern California

Chairman—A. R. Hooker, Jr., Pioneer-Flintkote Co., Los Angeles, Calif.
Vice-Chairman—W. H. Richards, Container Corp. of America, Los Angeles, Calif.
Secretary-Treasurer—S. C. George, Pioneer-Flintkote Co., Los Angeles, Calif.
Executive Committee—L. J. Deen, Volney Felt Mills, Compton, Calif.; T. S. Markov, Fibreboard Products, Inc., Los Angeles, Calif.; F. Searcy, U. S. Gypsum Co., South Gate, Calif.
Past-Chairmen—H. L. Joachim, U. C. Farmer, C. G. Frampton, W. A. Kinney, F. H. Wheelock, R. S. Buckley, John Van Ounsem, W. G. Hartford, B. F. Brown, Jr., R. W. Stevens, Claude Sharp, W. C. Birdsey, J. T. Cooey, and T. S. Markov.

Chesapeake and Allegheny Paper Club

Chairman—J. Symes, National Container Corp. of Virginia, Big Island, Va.
Vice-Chairman—R. B. Hobbs, National Bureau of Standards, Washington, D. C.
Treasurer—J. M. Weaver, Froehling & Robertson, Inc., Richmond, Va.
Membership Chairman—J. J. Priest, Halifax Paper Co., Roanoke Rapids, N. C. (First Meeting in Richmond, Va., on Sept. 17, 1954.)

Review of 1953–54 Section Meetings

The following review is a record of the meetings held by the Local Sections of TAPPI during the past year. These meetings were held from September to the end of June; those which were held in July or August were outings or business meetings. A report of the meetings held during the 1952–53 season was published in the September, 1953, issue of *Tappi*.

Pacific

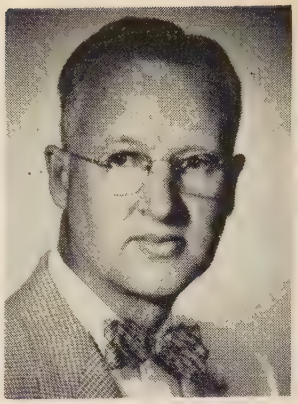
The Pacific Section was organized at Seattle, Wash., in June, 1929. The annual meeting is usually held in May.

Sept. 23–24 and 28–29, 1953 (Seattle, Wash., and Portland, Ore., respectively): The Seventh Annual Seminar on Hemicelluloses and Celluloses by Louis E. Wise, The Institute of Paper Chemistry, Appleton, Wis., and Emil Heuser, LaJolla, Calif.

Sept. 25, 1953 (Tacoma, Wash.): Annual Engineering Meeting, L. E. Hall, Weyerhaeuser Timber Co., Everett, Wash., moderating. (1) "Application of Vacuum Transfer to No. 2 Newsprint Machine at Crown Zellerbach Corp. Port Angeles Mill," by T. C. Smith, Crown Zellerbach Corp., Port Angeles, Wash. (2) "New Horizons in Water Filtration," by J. R. Sheridan, Northwest Filter Co., Seattle, Wash. (3) "Operating a Base Load Boiler on Variable Ratios of Bark Refuse and Fuel Oil," by E. R. Craig, Publishers Paper Co., Oregon City, Ore. (4) "Expansion, and Modernization Program at the Everett Pulp and Paper Mill of Simpson Logging Co.," by C. W. Cassell, Everett, Wash. Dinner meeting at Winthrop Hotel in Tacoma. Dinner speaker, A. H. Hooker, Hooker Electrochemical Co., Tacoma, Wash.

Nov. 3, 1953 (Longview, Wash.): "Products from Wood," A. H. Vroom of Weyerhaeuser Development Center, Longview, Wash., moderating. (1) "Paper Overlays for Veneer, Lumber, and Plywood," by R. J. Seidl, U. S. Forest Products Laboratory, Madison, Wis. (2) "By-Products from the Redwood Industry," by R. W. Miller, Pacific Lumber Co., Scotia, Calif. (3) "The Adaptability of Western Woods to the Manufacture of Dry Process Fiber Boards," by Ronald Frashour, Oregon Forest Products Laboratory, Corvallis, Ore. (4) "Hardboard by the Wet Process," by G. E. Tower, Forest Fiber Products Co., Forest Grove, Ore. Dinner meeting held in Monticello Hotel, Longview, Wash. Dinner speaker, Charles Gaupp of Portland State Extension Center, State System of Higher Education, Portland, Ore.

Jan. 19, 1954 (Everett, Wash.): General Mill Problems Meeting, L. V. Forman, technical director for the Pacific Coast Divisions of Scott Paper Co., moderating. (1) "Start-Up Problems at a New Kraft Pulp Mill," by Kenneth Chapman, Weyerhaeuser Timber Co., Everett, Wash. (2) "Corrosion Problems in the Pulp and Paper Industry," by R. B. Seymour, Atlas Mineral Products Co. (3) "Strength Development Through Stock Refining as Influenced by Certain Variables," by F. E. Caskey, Crown Zellerbach Corp. (4) "Mill Control of Beating and Refining," by J. d'A. Clark, Longview, Wash. Dinner meeting held in Everett Elks Club. Speaker, R. G. Tyler of Department of Civil Engineering, University of Washington.



H. R. Joiner, Champion Paper & Fibre Co.; Chairman, Ohio Section

F. W. O'Neil, New York State College of Forestry, Chairman, Central District, Empire State Section

March 19, 1954 (West Linn, Ore.): Shibley Award Meeting, Glen King, Crown Zellerbach Corp., West Linn, Ore., moderating. (1) "Effect of Variables on the Brightness of Unbleached Sulphite," by D. L. Mosher, Fibreboard Products, Inc., Port Angeles, Wash. (2) "Laboratory Beater Calibration—Unique '80 Grit Touch-up Method,' " by Frank Dinger, Puget Sound Pulp & Timber Co., Bellingham, Wash. (3) "Methods for Determining a Kraft Mill Sodium Balance," by Max Custis, Crown Zellerbach Corp., Camas, Wash. (4) Possible Improvements in the Routine Analysis of Ordnance Pulp," by J. F. Farrington, Scott Paper Co., Everett, Wash. Dinner meeting was held at West Linn Hotel. Dinner speaker, W. A. Dittmer, power manager for the Kaiser Aluminum & Chemical Corp.

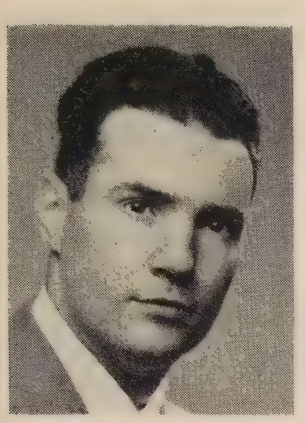
May 20, 21, 22, 1954 (Gearhart, Ore.): Joint Annual Spring Meeting with Pacific Coast Division of the American Pulp and Paper Mills Superintendents Association. (1) "A New Unit of Chip Measurement and Methods of Chip Compaction," by Edmund Ericksen, Longview Fibre Co., Longview, Wash. (2) "Comparison of Log Barkers," by W. E. Beeman, Crown Zellerbach Corp., Portland, Ore. (3) "Chips-Saws to Cars," by Thomas R. Miles, consulting products engineer, Portland, Ore. (4) "New Alloys for the Pulp and Paper Industry," by F. A. Guba Carpenter Steel Co., Union, N. J. (5) "Hot Pressing on Paper Machines," by W. W. Clarke, Longview Fibre Co., Longview, Wash. (6) "Effective Use of Manpower," by Gus Ostenson, Crown Zellerbach Corp., Camas, Wash. (7) "Reduction of Wood Waste," by C. C. Heritage, Weyerhaeuser Timber Co., Tacoma, Wash.

Lake States

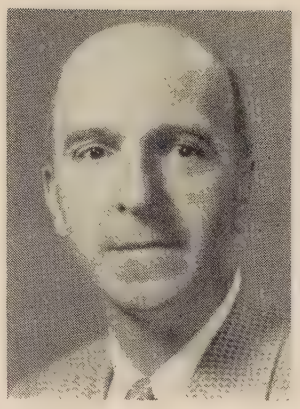
The Lake States Section was organized in Menasha, Wis., on Oct. 17, 1930. Meetings are usually held on the second Tuesday of the month in October November, January, March, April, and May. The meetings are held in Appleton and other cities in Wisconsin.

Oct. 15, 1953 (Eagle River, Wis.): Forestry tour from Trees for Tomorrow camp. Inspection of Star Lake plantation, pine plantation at Boulder Flats, Trout Lake Nursery, State fish hatchery at Woodruff, Rainbow Reservoir. Dinner at Club DeNoyer with after-dinner talk by Ernest Swift, conservation director, State of Wisconsin.

Nov. 10, 1953 (Appleton, Wis.): Panel program with H. F. Lewis, The Institute of Paper Chemistry, as moderator. Talks by the following men who had attended the International Congress of Pure and Applied Chemistry at Stockholm. (1) "Developments in Lignin Chemistry," by F. E. Brauns, The Institute of Paper Chemistry, Appleton, Wis. (2) "Developments in Cellulose Chemistry," by Kyle Ward, The Institute of Paper Chemistry, Appleton, Wis. (3) "Developments in Pulping, Spent Liquor Evaporation, and Yeast Production from Spent Liquor,"



J. C. Rice, Lowe Paper Co.; Chairman, Metropolitan District, Empire State Section



S. J. Young, Crown Zellerbach Corp.; Chairman, Northern District, Empire State Section

by A. J. Wiley, Sulphite Pulp Manufacturers Research League, Inc., Appleton, Wis. (4) "Wood Utilization and Chemicals from Wood," by H. F. Lewis, The Institute of Paper Chemistry, Appleton, Wis.

Jan. 12, 1954 (Appleton, Wis.): Panel program on the subject of "Refining." R. A. Vogt, Combined Locks Paper Co., Combined Locks, Wis., moderator: W. R. Haselton, Rhinelander Paper. Co., Rhinelander, Wis.; D. J. MacLaurin, The Institute of Paper Chemistry, Appleton, Wis.; F. X. Kreiling, Thilmany Pulp & Paper Co. Kaukauna, Wis.; Roy Nilsen, Northwest Paper Co., Cloquet, Minn.; H. P. Dixson, Fox River Paper Corp., Appleton, Wis.

March 11, 1954 (Wausau, Wis.): Visit during afternoon to the Wausau Paper Mills at Brokaw. Forum on "Testing Methods," G. J. Brabender, Marathon Corp., Rothschild, Wis., moderating. (1) "Moisture Testing of Paper," by J. D. Line, Mosinee Paper Co., Mosinee, Wis. (2) "Shortcomings in Testing Methods for Printing Papers," by G. W. Jones, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis. (3) "Strength Testing—Equipment and Methods," by H. W. Rowe, Nekoosa-Edwards Paper Co., Port Edwards, Wis. (4) "Testing Paper for Hygroexpansivity," by John Teeple, Marathon Corp, Rothschild, Wis.

April 13, 1954 (Forest Products Laboratory, Madison, Wis.): Tour of the Laboratory with discussion of current research activity. Dinner at Hotel Lorraine with after-dinner talk by Farrington Daniels, chairman of the Chemistry Department at the University of Wisconsin, on "Solar Energy."

May 11, 1954 (Stevens Point County Club, Stevens Point, Wis.): Election of officers; entertainment provided by Wausau Fun Band.

Delaware Valley

The Delaware Valley Section was organized at Philadelphia, Pa., in June, 1931. Meetings are held monthly at the Engineers Club, 1317 Spruce St., Philadelphia, Pa. The following meetings were held during the 1953–54 season.

Sept. 25, 1953 (Experimental Station of the Hercules Powder Co., Wilmington, Del.): After a tour through the Experimental Station a panel discussion on "Analytical Tools Available to the Paper Industry" was presented by personnel of the Hercules Powder Co., with W. H. Roberson as moderator. The subjects covered were: (1) "Chemical Analysis Using Infrared and Ultraviolet Radiation," by W. C. Kenyon. (2) "The Use of Instron Tensile Instrument for the Study of the Stress-Strain Properties of Paper," by W. Markwood. (3) "Defining the Surface Smoothness of Paper with the Brush Surface Analyzer," by E. J. Barber. (4) "X-Ray Diffraction as Applied to Papermaking Problems," by W. E. Fox. (5) "Microscopical Studies of Rosin Sizing," by C. W. Hock.

Oct. 22, 1953: "Corrosion in Action," by H. O. Teeple, International Nickel Co., New York, N. Y.

Dec. 4, 1953 (Riegel Ridge Clubhouse, Milford, N. J.): G. C. Borden of Riegel Paper Corp. acted as moderator for a panel discussion on "Dimensional Stability of Paper." The members of the panel were: C. R. Calkins, Riegel Paper Corp., Milford, N. J.; John Tongren, Hammermill Paper Co., Erie, Pa.; and J. J. Schwenkler, Container Corp. of America, Manayunk, Pa.

Jan. 28, 1954: "Semichemical Pulping Advances," by J. N. McGovern, Forest Products Laboratory, Madison, Wis.

March 25, 1954: "Odor Control in the Paper Industry," by L. B. Sjostrom, Arthur D. Little, Inc., Boston, Mass.

April 23, 1954: "Automation in the Pulp and Paper Industry," by R. H. Brown, Ernst & Ernst, Philadelphia, Pa.

May 27, 1954: Annual E. J. Albert Award Program. (1) "Basis Weight Variations and Their Effect on Size Press Coated Paper Properties," by M. M. Muntz, P. H. Glatfelter Co., Spring Grove, Pa. (winning presentation). (2) "Value of a Microscope for a Specialty Paper Mill," by J. W. Judge and B. H. Schrier, Riegel Paper Corp., Milford, N. J. (3) "Experience of a Paper Mill with Radioactive Fall-Out," by F. J. Slaby, Riegel Paper Corp., Milford, N. J. Judges: H. H. Hanson, W. C. Hamilton & Sons, Miquon, Pa.; H. C. Brill, E. I. du Pont de Nemours & Co., Newport, Del.; J. C. Dieffenderfer, Hercules Powder Co., Wilmington, Del.; and Father Mulloy, St. Joseph's College, Philadelphia, Pa.

Kalamazoo Valley

The Kalamazoo Valley Section was organized May 4, 1931, at Kalamazoo, Mich. Its meetings are usually held at the Hotel Harris in Kalamazoo, Mich., on the first Thursday of each month.

Oct. 1, 1953: "The Utilization of Wastepaper," by H. J. Perry, Waste Paper Utilization Council, New York, N. Y. Also, Frank Halloran, Wisconsin Wire Works, Appleton, Wis., presented a movie, "Weaving Wisconsin Wires."

Nov. 5, 1953: "A New Concept of Paper Mill Drying," by J. R. Gillis, Martinson Machine Co., Kalamazoo, Mich.

Dec. 3, 1953: "The Significance of Paper Tests," by J. A. Van den Akker, The Institute of Paper Chemistry, Appleton, Wis.

Jan. 14, 1954: 19th Annual Kalamazoo Valley Papermakers' Get-Together held jointly with the Michigan Division of the American Pulp and Paper Mill Superintendents Association. "The Task Ahead," by George Olmsted, Jr., S. D. Warren Co., Boston, Mass.

Feb. 4, 1954: J. C. Barthel, American Cyanamid Co., presented a talk on the sizing of neutral and alkaline papers.

March 4, 1954: Graphic Arts meeting held jointly with the Michigan Division of the American Pulp and Paper Mill Superintendents Association. "The Effect of Letterpress Research on Paper Specifications," by P. J. Thoma, Springdale Laboratories, Time, Inc., Springdale, Conn.

April 1, 1954: "Human Engineering in the Pulp and Paper Industry," by G. H. Pringle, The Mead Corp., Chillicothe, Ohio.

May 6, 1954: Annual Senior Thesis Presentation. Seniors, Paper Technology Department, Western Michigan College, Kalamazoo, Mich.

June 8, 1954 (Gull Lake Country Club): Annual Fun Day. Election of 1954–55 officers.

New England

The New England Section was organized at Holyoke, Mass., on Dec. 9, 1932. The following meetings were held during the current year:

Oct. 9, 1953 (Great Barrington, Mass.): (1) "Stream Improvement Problem in New England," by Russell L. Winget, National Council for Stream Improvement, New York, N. Y. (2) "How Statistics Can Be Used to Control Quality in Papermaking," by J. F. Theriault, Robert Gair Co., Inc., Uncasville, Conn.

Dec. 4, 1953 (Holyoke, Mass.): Mill Visit to Chemical Paper Mfg. Co., Holyoke, Mass. (1) "Analysis of Variance in Dealing with Mill Data," by Geoffrey Beall, University of Connecticut, Storrs, Conn. (2) "Waste Disposal Problems of the Small Mill," by H.W. Gehm, National Council for Stream Improvement, New York, N. Y.

March 19, 1954 (Hartford, Conn.): (1) "Some Quick and Easy Statistical Methods," by John D. Hinchen, Monsanto Chemical Co., Springfield, Mass. (2) "Biological Oxidation—Friend or Foe?" by H. E. Orford, Department of Sanitation, Rutgers University, New Brunswick, N. J. Mill visits to Lydall & Foulds Paper Co., Colonial Board Co., and Rogers Corp. preceded the above talks.

June 11–12, 1954 (Magnolia, Mass.): (1) "A Customer's View of Quality Control in Specialty Papermaking," by D. L. Boyd, Airway Electric Appliance Corp., Toledo, Ohio. (2) "Methods and Equipment for the Clarification of White Water," by N. J. Lardieri, National Council for Stream Improvement, New York, N. Y.

Ohio

The Ohio Section was organized on Nov. 30, 1934, at Middletown, Ohio. Meetings were held during the past year

at the Manchester Hotel in Middletown, unless indicated otherwise.

Oct. 8, 1953: "Recent Pulp Developments," a panel discussion. (1) "Recent Developments in Semichemical Pulping," by J. N. McGovern, Forest Products Laboratory, Madison. Wis. (2) "Recent Developments in Sulphite and Sulphate Pulping," by H. W. Bialkowsky, Weyerhaeuser Timber Co., Longview, Wash.

Nov. 10, 1953: "Problems of Closing a White Water System," a panel discussion. Panel consisted of: Arthur Thurn, Champion Paper & Fiber Co., Hamilton, Ohio; H. A. Smith, The Mead Corp., Chillicothe Ohio; C. K. Hill, Sorg Paper Co., Middletown, Ohio; and Russell Vannatta, Excello Products Co., Cincinnati, Ohio.

Dec. 8, 1954: "Radio Isotopes in the Paper Industry," by C. A. Sankey, Ontario Paper Co., Thorold, Ont.

Jan. 12, 1954: "Statistical Quality Control," by B. E. Sooy, Gardner Board & Carton Co., Middletown, Ohio.

Feb. 11, 1954: "Printing—Past, Present and Future," by W. C. Huebner, Huebner Laboratories, Mamaroneck, N. Y.

March 9, 1954: "The Challenge of Dynamics," by S. D. Kirkpatrick, McGraw-Hill Book Co. *Chemical Engineering,* and *Chemical Week.*

April 8, 1954: Panel discussion: "New Starch Developments," by J. T. Schock, Corn Products Sales Co., Argo, Ill.; J. P. Casey, A. E. Staley Mfg. Co., Decatur, Ill.; and J. E. Kellinger of Penick and Ford, Ltd., Inc., Cedar Rapids, Iowa. A plant tour of the Indianapolis, Ind., plant of National Starch Products, Inc. was also held during the day. A. T. White of National Starch Products, Inc., New York, N. Y., presented the evening paper entitled "Starches Tailor-Made for the Paper Industry."

May 11, 1954 (Hartwell Club House, Cincinnati Gas & Electric Co., Cincinnati, Ohio): Annual meeting featuring a Ladies' Night. Entertainment and election of officers.

Empire State

The Empire State Section began holding meetings in 1935, and received its charter on April 2, 1938. In 1943, the Section was reorganized on a regional basis with meetings being held in four districts (Central, Eastern, Northern, and Western) of New York State. In 1948, the Metropolitan District was added.

May 7, 1954 (University Club, Syracuse, N. Y.): Fourth annual dinner for the Seniors at the College of Forestry, State University of New York. C. H. Kent, Hercules Powder Co., was the speaker.

June 10–12, 1954 (Lake Placid, N. Y.), Annual Meeting: (1) "The Application of PE and PE-Wax Blends by Extrusion and Roller Coater Methods," by G. L. Booth, Dilts Machine Works, Fulton, N. Y. (2) "The Modification of Plastic Films for Specific Packaging Needs," by J. B. Sisson, St. Regis Paper Co., Deferiet, N. Y. (3) "The Rotobelt," by Sam Orton, Jr., Orton Corp., Fitchburg, Mass. (4) "New Chemical Products of Interest to the Paper Industry," by John Bainbridge, Monsanto Chemical Co., and B. W. Weimer, E. I. du Pont de Nemours & Co., Inc. (5) "Odor Testing in Paperboard," by R. T. Russell, Syracuse University, Syracuse, N. Y. (6) "Applications of the Hurletron Automatic Caliper and Basis Weight Control to Paper and Paperboard Machines," by C. M. Noble, Electric Eye Equipment Co. (7) "New Chemical Products of Interest to the Paper Industry," by Warren Kumblad, Socony-Vacuum Oil Co., New York, N. Y. (8) "The Ancient Art of Chinese Paper Making," a movie presented by E. D. Jones & Sons, Pittsfield, Mass. (9) "Stream Improvement"—A Symposium, Moderator, J. D. Parmele, St. Regis Paper Co., Deferiet N. Y.; R. M. Drummond, International Paper Co., Glens Falls, N. Y.; V. P. Edwardes, Consultant, Corinth, N. Y.; H. W. Gehm, National Council for Stream Improvement; and W. H. Larkin, New York State Department of Health.

Central District (University Club, Syracuse, N. Y., first Friday of month)

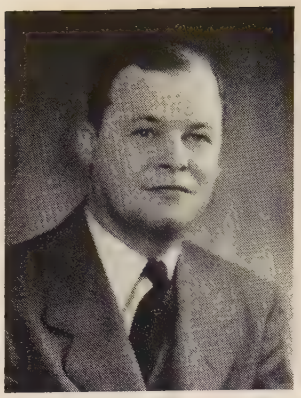
Oct. 2, 1953: "Set-up Boxes and Folding Boxes for the Paper Trade," by E. K. Mullen, Boxboard Division, Robert Gair Co., New York, N. Y.

Nov. 6, 1953: "Cylinder Machine Vats," by H. A. Norseen, Pusey & Jones Corp., Wilmington, Del.

Dec. 4, 1953: "Cylinder Felts for the Syracuse Area," by B. L. Channer, H. Waterbury & Sons Co., Oriskany, N. Y.

Jan. 8, 1954: "The Relation of Paper Quality to Corrugating Board Sales," by W. J. Trimble, Robert Gair Co., Syracuse, N. Y.

Feb. 5, 1954: "Use of Starches as an Additive and Adhesive in Paper and Paperboard," by J. P. Casey, A. E. Staley Manufacturing Co., Decatur, Ill.



J. J. Forsythe, International Paper Co.; Chairman, Western District, Empire State Section

A. E. Jones, Oxford Paper Co.; Chairman, Maine-New Hampshire Section

March 5, 1954: "The Manufacture of Tissues," by W. H. Holl, Victoria Paper Mills Co., Fulton, N. Y.

April 2, 1954: "Printing of Paper and Paperboard," by F. B. Lincoln, Time-Life Laboratories, New York, N. Y.

May 7, 1954: "Forty Years of Selling," by C. H. Kent, Hercules Powder Co., Holyoke, Mass. (Senior dinner sponsored by Empire State Section.)

June 4, 1954: Ladies' night.

Eastern District (Milfranks Restaurant, Lake George Rd., Glens Falls, N. Y., third Thursday of month)

Oct. 15, 1953: "Wires," by Smith McLandress, Appleton Wire Co., Appleton, Wis.

Nov. 19, 1953: (1) "Selecting, Measuring, and Developing Men," by Baker Middelton, Marinette Paper Co., Fort Edward, N. Y. (2) "Some Practical Aspects of Industrial Training," by R. P. Beaudette, International Paper Co., Palmer, N. Y. (3) "Technical Training Programs," by H. L. Field, West Virginia Pulp & Paper Co., Mechanicville, N. Y.

Dec. 16, 1953: "Rosin and Alum Reactions," by R. W. Kumler, American Cyanamid Co., New York, N. Y.

Jan. 21, 1954: "Principles and Application of Vortex Cleaners," by E. L. Rastatter, Bauer Brothers, Springfield, Ohio.

Feb. 25, 1954: (1) "Experimentation of Sodium Hydroxide in Bleaching of Sulphite with Peroxide," by Norman Rauscher, Diamond Match Co., Plattsburg, N. Y. (2) "Bleaching of Semichemical Pulp and Sulphite with Chlorine," by Gilbert Robinson, West Virginia Pulp & Paper Co., Mechanicville, N. Y. (3) "Bleaching of Waste Paper," by R. M. Drummond, International Paper Co., Glens Falls, N. Y.

March 19, 1954: Pulp Evaluation Panel: Chairman, G. C. Cole; moderator, C. N. Hagar. Both the Diamond Match Co., Plattsburg, N. Y. Speakers: E. H. Johnson, Stevens & Thompson Paper Co., Greenwich, N. Y.; H. H. Lavery, International Paper Co., Palmer, N. Y.; Paul Page, Imperial Paper & Color Corp., Glens Falls, N. Y.; J. W. Dappen, Marinette Paper Co., Fort Edward, N. Y.

April 22, 1954: Empire State Award Contest Papers. Eastern District. (1) "The Effect of Adhesives Used on the Theoretical Properties of Several Coating Colors," by Miss C. Y. Chu, International Paper Co., Glens Falls, N. Y. (2) "Pulp and Paper Mill Industrial Waste Surveys," by Gordon Rabeler, International Paper Co., Glens Falls, N. Y. (3) "Bleach Plant Engineering and Design," by A. G. Bellows, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y. (4) "Supercalenders—Super Headaches," by Jud Hannigan, International Paper Co., Palmer, N. Y.

May 20, 1954: Ladies' night

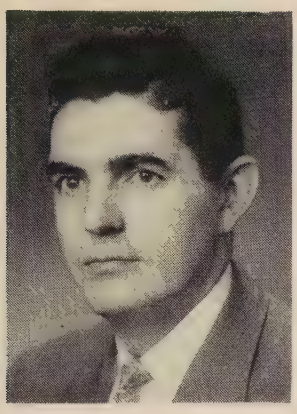
Metropolitan District (Fraunces Tavern, New York, N. Y., second Tuesday of month)

Sept. 22, 1953: Panel discussion, "Product Development in Industrial Packaging," by Gardiner Lane, K. A. Arnold, and G. T. Joyce, St. Regis Paper Co., New York, N.Y.

Oct. 20, 1953: Panel discussion, "Problems in Waste Paper Utilization," by H. J. Perry, Waste Paper Utilization Council, New York, N. Y.; H. G. Booth, Robert Gair Co., Uncasville, Conn.; F. C. Goodwill, St. Regis Paper Co., New York, N. Y.

Nov. 10, 1953: Panel discussion, "Flexographic Printing," by J. W. Viner, Interchemical Corp., New York, N. Y.; R. K. Zuckerman, Kidder Press Co., Dover, N. H.; J. LaCraw, Mosstype Corp., New York, N. Y.

Dec. 8, 1953: (1) "The Chemistry of Aluminum Sulphate and Related Compounds as Used in Paper and Board Manufacture," by A. W. Thomas, Columbia University, New York, N. Y. (2)



L. D. Shand, Monsanto Chemical Co.; Chairman, Lake Erie Section

M. B. Pineo, Brunswick Pulp & Paper Co.; Chairman, Southeastern Section

"Aluminum Sulphate and Sodium Phospho Aluminate in Paper Manufacture," by D. Lurie, American Cyanamid Co., New York, N. Y.

Jan. 12, 1954: "Some Aspects of the Application of CMC to Paperboard to Improve Gloss Ink Printing," by H. O. Ware, Hercules Powder Co., Wilmington, Del.

March 9, 1954: "The Importance of Wood Utilization," by H. F. Lewis, Institute of Paper Chemistry, Appleton, Wis.

April 13, 1954: "Insulating Paper for High Tension Cables," by W. A. Del Mar, Habirshaw Cable and Wire Div., Phelps Dodge Copper Products Corp. Motion picture, "Voices in Paper," courtesy Western Electric Co.

May 11, 1954: Ladies' night. "The Nation's Fifth Industry—Its Marvelous Expanse and Unexplored Domains," by Miss E. P. Nuttall, *Paper Trade Journal*, New York, N. Y. Motion picture, "Life with Paper," courtesy American Cyanamid Co., New York, N. Y.

NORTHERN DISTRICT (Hotel Woodruff, Watertown, N. Y., second Thursday of month)

Oct. 8, 1953: "Present Developments in European Pulp and Paper Manufacture," by K. A. Arnold, St. Regis Paper Co., Deferiet, N. Y.

Nov. 12, 1953: "The Importance of and Problems with Waste Paper," by H. J. Perry, Waste Paper Utilization Council, New York, N. Y.

Dec. 10, 1953: "Slime Control," by Paul Sartoretto, W. A. Cleary Corp., New Brunswick, N. J.

Jan. 13, 1954: "The Research Department Looks at the Paper Machine," by W. Gallay, E. B. Eddy Co., Hull, Que.

Feb. 11, 1954: "Lithography and the Paper Maker," by R. K. Newcomb, John Waldron Corp., New Brunswick, N. J.

March 10, 1954: Panel discussion, "Groundwood Bleaching." Moderator, D. M. Ferguson, St. Regis Paper Co. Panel members: Paul Bretschger, BECCO, Niagara Falls, N. Y.; George Smedberg, E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y.; George Rittenhouse, Virginia Smelting, New York, N. Y.; L. Poccia and R. Dando, St. Regis Paper Co., Deferiet, N. Y.

April 8, 1954: "The Va-Purge Process," by John Hart, Pulp & Paper Research Institute of Canada, Montreal, Que.

May 13, 1954: Ladies' night.

WESTERN DISTRICT (Prospect House, Niagara Falls, N.Y ., first Wednesday of month)

Oct. 7, 1953: "Factors in Design of a Waste Paper Cleaning System for Board Mills," by J. T. Loomer, Robert Gair Co., Uncasville, Conn.

Nov. 4, 1953: "Experiences in Europe in the Field of Deinking," by A. H. Nadelman, Western Michigan College, Kalamazoo, Mich.

Dec. 2, 1953: "The Efficient Use of Dyestuff in Paper Making," by E. P. McGinn, Sandoz Chemical Works, Inc., New York, N. Y.

Feb. 3, 1954: "High Density Super Bleaching of Chemical Pulps," by F. R. Sheldon and I. C. MacGugan, Buffalo Electrochemical Co., Buffalo, N. Y.

March 9, 1954: Joint meeting CPPA at Queensway Hotel, St. Catherines, Ont. Paper presented by Ross Engineering Co. Title not given.

May 6, 1954: Ladies' night. "Beauty by the Yard," by W. S. McClintock, Armstrong Cork Co., Lancaster, Pa.

Maine-New Hampshire

The Maine-New Hampshire Section was organized at Orono, Me., on Oct. 25, 1940, and received its charter at Bangor, Me., on Oct. 26, 1945.

Oct. 23–24, 1953: (1) "Use of Silicate Pigment in Paper," by L. B. Taylor, Columbia-Southern Chemical Co., Pittsburgh, Pa. (2) "Mannogalactan Additives in Paper," by R. D. McCarron, Morningstar, Nicol, Inc., Boston, Mass. (3) "Natural Gum Products as Aids in Improving Paper Quality," by M. L. Cushing, Stein, Hall & Co., New York, N. Y. (4) "New Techniques for Enzymes Converting Starch," by L. J. Wood, National Starch Products, Inc., Boston, Mass. (5) "Pigmented Size Press Coatings Containing Dow Latex 512K," by L. H. Silvernail and E. J. Heiser, Dow Chemical Co., Midland, Mich. (6) "Sveen Glue," by Richard Tutt, Jr., Peter Cooper Corp., Gowanda, N. Y. (7) "Use of Protein Condensates to Promote Retention of Fillers," by M. H. Diem and L. F. Leighton, Jr., Keratene Co., Winsted, Conn. (8) "Foam on the Paper Machine," by Anthony Wirpsa, E. F. Houghton & Co., Philadelphia, Pa. (9) "Improving Sheet Formation," by J. E. Ward, D. E. Hall, C. E. Snook, and C. H. Lighthite, Nopco Chemical Co., Harrison, N. J. (10) "Potential Hazards," by H. E. Berg, National Aluminate Corp., Chicago, Ill.

June 18–19, 1954: (1) "Pulpwood Resources of Northern New England," by V. S. Jensen, U. S. Forest Service, Laconia, N. H. (2) "The Recovery of Ammonia by Simultaneous Evaporation of Acid and Alkaline Waste Liquors and Re-use for Pulping," by L. C. Jenness, University of Maine, Orono, Me. (3) "Semichemical Pulping at Bathurst," by R. J. B. Keswick, Bathurst Power & Paper Co., Bathurst, N. B. (4) "Recent Developments in Masking Sulphate Pulp Mill Malodors," by B. K. Tremaine, Rhodia, Inc., New York, N. Y.

Chicago

The Chicago Section was organized as the Chicago Professional Paper Group in Chicago, Ill., in October, 1943. In 1946 the group became the Chicago Section. All meetings are held in the rooms of the Chicago Bar Association on the third Monday of each month.

Sept. 21, 1953: "Developing New Market for Paper," by Philip Barber, Barber and Baar Associates, Inc., New York, N. Y. A. Asherman, American Cyanamid Co., and G. E. Fromm, American Cyanamid Co., New York, N. Y.

Oct. 19, 1953: "What is Needed in Packaging by the Food Chains," by Val Bauman, National Tea Co., Chicago, Ill.

Nov. 16, 1953: "Panel Discussion on Adhesives." (1) "Resin Adhesives," by Robert Pett, National Adhesives, Div., of National Starch Products, Chicago, Ill. (2) "Latex Adhesives," by Edward Higbee, consultant, Chicago, Ill. (3) "Dextrines and Animal Adhesives," by C. S. Young, Swift & Co., Chicago, Ill.

Jan. 18, 1954: "Relationship of Food Allergies to Paper" by T. G. Randolph, specialist in allergies, Chicago, Ill.

Feb. 15, 1954: "Lithography in Today's Paper Business," by R. F. Reed, Lithographic Technical Foundation, Chicago, Ill.

March 15, 1954: "The Chem-dry Process," by H. L. Barnebey, Meyercord Co., Pittsburgh, Pa.

April 19, 1954: "A New Development in Printing," by W. C. Huebner, Huebner Laboratories, Mamaroneck, N. Y.

May 17, 1954: "Use of Northern Hardwood in Paper and Paperboard," by B. W. Martin, American Boxboard Co., Filer City, Mich.

Lake Erie

The Lake Erie Papermakers and Converters Association was organized at the Hickory Grille, Cleveland, Ohio, on Oct. 7, 1949. Meetings are held on the third Friday of each month at the Carter Hotel, Cleveland, Ohio. This organization received its charter as the Lake Erie Section on May 18, 1951.

Sept. 25, 1953: Guided tours were conducted through the Consolidated Paper Co., Monroe Paper Products Co., and River Raisin Paper Co. at Monroe, Mich. Dinner was held at the Monroe Golf and Country Club and the meeting that followed was on "Shipping Damage Preventive Measures." The speakers were C. R. Anderson, Association of American Railroads, and Charles Turner, Chrysler Corp., Center Line, Mich.

Oct. 16, 1953: "Specialty Adhesives," by A. J. Krusick, Paisley Products Inc., Cleveland, Ohio, and W. A. Foll, National Adhesives, Cleveland, Ohio.

Nov. 20, 1953: "Corrugated Quality." The speakers were

Earl Candell, General Electric Co., Nela Park Div., Cleveland, Ohio, and George Lecky, The Kress Box Co., Pittsburgh, Pa.

Dec. 12, 1953: Christmas party.

Jan. 15, 1954: "Human Relations," by W. R. Bryan, Goodyear Tire & Rubber Co., Akron, Ohio.

Feb. 26, 1954: "Packaging from the Customer's Standpoint," by J. D. Wallace, Procter and Gamble, Cincinnati, Ohio.

March 19, 1954: "Chemicals as an Aid to the Papermaker and Converter," by C. A. Markee, Ohio Boxboard Co., Rittman, Ohio.

April 23, 1954: "New Developments in Converting Paper and Board Products," by R. L. Lewis, Ohio Boxboard Co., Rittman, Ohio. Election of officers for the coming year followed the meeting.

May 21, 1954: Graphic Arts. Installation of new officers for the coming year. Sinclair and Valentine Co., manufacturers of printing inks, presented a film on "The Manufacture of Printing Inks" and a representative to narrate on the film and answer questions which followed the film.

Southeastern

The Southeastern Section was organized in Macon, Ga., during the Summer of 1951 as the Southeastern Pulp and Paper Society, and received its charter at Brunswick, Ga., on Sept. 19, 1952. Meetings are held five times during the program year on dates and in cities designated by the Executive Committee in South Carolina, Georgia, and Florida.

Sept. 25-26, 1953 (St. Simons Island, Ga.): (1) "Cost Estimation for Process Operation," by H. W. Schweyer, University of Florida, Gainsville, Fla. (2) "Research in Tree Improvement at Lake City, Florida," by K. B. Pomeroy, U. S. Forest Service, Lake City, Fla. (3) "Automatic and Remote Control Applications to Stock Preparation Systems," by J. H. Pearson (Presented by Tany Agronin), The Black-Clawson Co., Hamilton, Ohio. (4) "Description of the St. Marys Kraft Corp. Plant, St. Marys, Ga.," by G. W. Brumley, St. Marys Kraft Corp. Guided tour of St. Marys Kraft Corp. mill at St. Marys, Ga.

Dec. 4-5, 1953 (Charleston, S. C.): (1) "The Southern Wood Pulp Industry—Past, Present, and Future," by D. G. Moon, J. E. Sirrine Co., Greenville, S. C. (2) "The Chemical Engineer and the Pulp and Paper Industry," by L. C. Jenness, University of Maine, Orono, Me. (3) "Possible Processes for Recovery of Soda and Sulphur from Semichemical and Soda Base Acid Sulphite Waste Liquors," by Gerald Haywood, West Virginia Pulp & Paper Co., Luke, Md. (presented by W. F. Cook, West Virginia Pulp & Paper Co., Charleston, S. C.). Guided tours of West Virginia Pulp & Paper Co. and General Asbestos and Rubber Co. plants at North Charleston, S. C.

Jan. 22-23, 1954 (Macon, Ga.): Evening Session—(1) "What You Should Know About Gas Turbines for Paper Mills," by W. C. Bloomquist, General Electric Co., Schenectady, N. Y. (2) "The Effect of Cooking Conditions in Neutral Sulphite Pulping of Sweet Gum," by J. J. Owen, E. J. McCue, and R. R. Chase, Union Bag & Paper Corp., Savannah, Ga. (3) "The Hemicelluloses of Wood; Their Significance to the Pulp and Paper Industry," by L. E. Wise, The Institute of Paper Chemistry, Appleton, Wis. Morning Session (23rd)—papers and panel discussion on "Personnel Testing and Personnel Relations," C. N. Rogers presiding. (1) "Personnel Factors in Job Success," by L. W. Ross, Union Bag & Paper Corp., Savannah, Ga. (2) "Psychobiological Unit in Industry," by E. M. Gunn, M.D., of Sonoco Products Co., Hartsville, S. C.

March 19-20, 1954 (Jacksonville, Fla.): (1) "Television in Industry," by R. H. Renko, Diamond Power Specialty Corp. (2) "Fire Protection in Pulp and Paper Mills," by R. C. Max and presented by R. M. Taft, both of Factory Insurance Association. (3) "The Saline Dilution Method of Liquid Flow Measurements," by J. H. Mappus, Jr., of West Virginia Pulp & Paper Co., Charleston, S. C. (4) "Chemigroundwood—Your Hardwood Mechanical Pulp," by F. W. O'Neil, State University of New York College of Forestry, Syracuse, N. Y. (5) "Description of the St. Regis Jacksonville Mill," by John K. Ferguson, St. Regis Paper Co. Guided tour of St. Regis Paper Co. mill, Jacksonville, Fla.

May 14-15, 1954 (Savannah, Ga.); (1) "By-Products of the Pulping Industry," by J. B. Bain, Glidden Co., Naval Stores Div., Jacksonville, Fla.: (2) "Water Softening Experience with Polystyrene Ion Exchange Resins," by W. S. Cummings and C. L. Smith, National Container Corp., Jacksonville, Fla. (3) "A Preliminary Survey of Chip Size," by G. N. Kemp, R. H. Stevens, and R. C. Sproull, Herty Foundation Laboratory, Savannah, Ga. (4) "Ideas on Management-Employee Relations," by G. W. E. Nicholson, Union Bag & Paper Corp., New York, N. Y. (5) Description of Southern Paperboard Corp. mill at Port. Wentworth, Ga., by Claude Adams, Southern Paperboard Corp. Election of officers. Guided tour of Southern Paperboard Corp. plant.

Papermakers and Associates of Southern California

The Papermakers and Associates of Southern California was organized at Los Angeles, Calif., on May 15, 1941. Meetings are held in Los Angeles on the third Thursday of alternate months.

Sept. 17, 1953: "Sizing," by P. E. Neumann, Hercules Powder Co., Wilmington, Del.

Nov. 19, 1953: "Felts," a panel discussion by George Eberhard, Fibreboard Products, Inc., William Richards, Container Corp. of America, and Glen Phillips, Pioneer-Flintkote Co., Los Angeles, Calif.

Jan. 21, 1954: (1) "What Does the Printing Man Expect of Board?" by Andrew Cothill, General Printing Ink Co. (2) "Testing Procedures for Printing Inks," by David McCash, California Ink Co. (3) "What to Expect of New Inks in the Future," by Al Seth, Sinclair & Valentine Co. of California.

March 12, 1954: "Stock Preparation," by O. E. Larson, Emerson Manufacturing Co., Lawrence, Mass.

May 8, 1954: Wino-Dino Social Program.

May 20, 1954: "Stock Cleaning," by Tany Agronin, Shartle Bros. Machine Co., Middletown, Ohio.

July 15, 1954: "Oil Mist Lubrication," by Lawrence Okey, Clenite Co., Los Angeles, Calif.

LETTERS TO THE EDITOR

Fibrous Agricultural Residues Pulp Mill

To the Editor, *Tappi:*

We are planning to build a small pulp and board plant to produce 20 tons a day of pulp using wastes of sugar cane, wheat straw, and some other similar fibers. I want the information on the following subjects.

1. Systems used in collecting and baling the straw on the field and manufacturers of equipment for making this work.
2. Most convenient and most used types of digesters for this kind of material.
3. Systems to charge the digesters, i.e., the loading done with the bales as such or is it necessary to open them? How is it possible to get the maximum load per unit volume by compressing the material inside the digester? Please inform me about the maximum capacity I can expect per unit volume of digester using wheat straw for instance.
4. Which are the recommended types of digesters used for the treatment of straw? Which chemicals and which compositions of liquors? What schedule in each case?
5. Yields expected with the most common types of straw.
6. Equipment used for washing and screening such kinds of pulps. In handling short and fine fibers, what are the types of washers, screens, deckers, board machines, etc? The problem is to avoid as much as possible the loss of fibers across the meshes in all the equipment.
7. Equipment for lapping this pulp. Must we use the conventional type of wet machine? Remember that we produce board in sheets and we want to use one of the cheapest board machines.

ENRIQUE SUAREZ S.
Fabrica de Papel San Rafael
San Rafael, Mexico, D. F.

To the Editor, *Tappi:*

1. In this country practically all of the grain is harvested by the combine method. The straw is then raked into windrows and baled from the windrows by a pickup baler. Generally this is a one-man operated, automatic, wire-tie machine making bales of 50 to 80 lb. Most of the farm equipment manufacturers in the United States produce such machines and for further information on these machines we refer you to

R. A. Jones, executive secretary, Farm Equipment Institute, 608 S. Dearborn St., Chicago 5, Ill.

2. The digesters mostly used up to the present time in this country are the rotary types, generally 14 ft. in diameter.

3. Most of the mills load the bales directly into the digester, merely removing the wire before dropping the bale. After this first filling the digester is closed and steamed and reopened. The steaming has a wilting action on the straw and more straw is now charged. The mills use from one to four fills in this manner. In some cases the chemical is charged into the rotary at the beginning of the cooking. About the maximum charge that can be put into the digester in this way is 5 tons (2000-lb. tons). Two mills on the Continent, one in this country and one in Canada, are now reported to be chopping the straw prior to loading into the digester. We do not have any further detailed information on their operations.

4. Most of the mills have eliminated the use of lime as a cooking chemical and many of them are now using the chemicals such as outlined in the enclosed reprint "Improved Straw Pulp for Corrugating Paper." The cooking schedule varies drastically with each mill but the average is approximately 5 hours at 140°C.

5. Most of the mills report pulp yields of about 67% of the purchased straw.

6. Most of the washing of these pulps is carried out in beaters fitted with washer drums. Some of the mills use the ordinary type of machine screens and some use Jonsson screens. Most of the strawboard in this country is made on cylinder machines but some fourdriniers are also used.

7. So far as we know, there is no lapping of a strawboard pulp in this country since all the mills making this pulp consume it in their own papermaking operations. However, there is no reason why you couldn't use either your cylinder or fourdrinier board machine as a wet lap machine by taking the sheet off the presses before going into the driers.

The above, as you realize, is for the present types of operations carried on in this country. We believe that the mechanochemical process developed at this laboratory is much more suitable, both technologically and economically, for making board and fine pulps from straws and similar agricultural residues, and we are pleased to enclose reprints of articles from this laboratory describing our work on this process. You might be interested to learn that the Cia. Industrial de San Cristobal, S. A., which is producing pulp from bagasse in Mexico, is using an operation based on this process. For further information on this operation we suggest that you contact Dr. Dante S. Cusi, president of this company, Ave. Hidalgo 5, Mexico 1, D. F.

S. I. Aronovsky, *in charge*
Pulp and Paper Unit
Agricultural Residues Section
Northern Utilization Research Branch
Peoria, Ill.

Effect of Light on Roofing Papers

To the Editor, *Tappi:*

With reference to the article published in *Tappi*, "Effect of Light on Coated Groundwood Papers," by Wilson and Harvey. We are particularly interested in this research from the standpoint of deterioration of roofing felt, especially in Southern California, where the actinic rays are said to be somewhat stronger than at many other locations in the United States.

Our specific problem is concerned with deterioration of felt roofs in which 90-lb. uncoated slate covered cap sheets are used. On exposure there comes a time when the cap sheet, although giving some protection, may develop a few slits here and there. At the same time the larger part of the roof is intact and it might seem to appear feasible to repair the few slits or put a roof coating over the whole roof, thus obtaining a few more years' service. This does not work out in practice, however, in and around Los Angeles. If these cracks are repaired by stripping roof putty or emulsified asphalt with some type of fabric to reinforce the cracks, the original cracks will be sealed all right, but new ones will appear in several months adjacent to the old ones. In the case of the roof being recoated, the entire roof will become cracked within three months of the time the coating material has been applied. We feel that the work of Wilson and Harvey may answer at least one of our questions concerning disintegration of roofing felt.

Some years ago our laboratory made an attempt to determine the effect of actinic rays on uncoated roofing felt by erecting a sort of glass-covered skylight over a section of a roof in order to filter out most of the ultraviolet rays. The structure was raised slightly from the roof so that air circulation could take place and so that there would be the minimum of heat accumulation over the patch. Unfortunately there was no way to control night dew fall or fog which was largely eliminated from the glass-covered panel although a heavy precipitation such as rain washed under the glass and wet the panel during those periods. We concluded from these crude tests that the light shielded roofing outlasted the control (which was exposed to direct rays of the sun as on a normal roof) by a factor of about 0.5, or half again longer than the control.

C. M. Wakeman, *Testing Engineer*
Los Angeles Harbor Dept.
Wilmington, Calif.

Speed of Newsprint Machines

To the Editor, *Tappi:*

Would you please be kind enough to let me have the following information:

(a) The first newsprint machine which ran at 1000 f.p.m. It is my understanding, from W. H. Millspaugh, that this was at the Great Northern Mill, round about 1924/26.

(b) As Powell River has run newsprint at just over 2000 f.p.m., I would be very pleased to know whether you have records of any machine running as fast as this on newsprint.

As you are undoubtedly aware, suction rolls made possible the 1000 f.p.m., and the 2000 f.p.m. has been made practical by vacuum pickup—both developments having been pioneered by Millspaugh.

R. C. Heys, *Managing Director*
Millspaugh Ltd.
Sheffield, England

To the Editor, *Tappi:*

It is our understanding that the first newsprint machine which ran at 1000 f.p.m. was The Great Northern Paper Co., Millinocket, Me., in April, 1921. In August, 1921, the Laurentide mill at Grand' Mere, Que., also ran a machine at 1000 f.p.m.

Powell River is the only mill to have reached 2000 f.p.m., though this was for a 1-hour run only. Baie Comeau still holds the record of 1925 f.p.m. for a full day's run, and is running continuously at over 1800 f.p.m.

A. John Winchester
Tappi, New York, N. Y.

Sulphate Pulping Terms

To the Editor, *Tappi:*

I am writing with reference to the proposed revision of O-400 p-44, Standard Terms Used in the Sulphate Pulping Process, as published in page 170A of the November, 1953, issue of *Tappi.*

Yesterday afternoon, we had a long conference at this office

regarding the serious problem of sulphate digester corrosion. A number of us who have been in this particular problem rather deeply, have been struck by the fact that the customary methods of analyzing (and reporting) sulphate green liquor, white liquor, and black liquor do not cover some items which probably are of the utmost importance in connection with the sulphate digester corrosion problem. I am speaking here not so much with reference to O-400 p-44, but more particularly with reference to T 624 m-44, Analysis of Sulphate White and Green Liquors; and T 625 m-48, Analysis of Sulphate Black Liquor. We have also noticed in particular, a total lack of ability to correlate our own sulphate digester corrosion experience with our records on green and white liquor customary analyses. For years, our monthly reports on green liquor and white liquor analyses have included the following items (I will not bother at this point to define the terms; but our use of said terms is fairly well covered on pages 70A and 72A of the June, 1954, issue of *Tappi*): Total Alkali, as Na_2O; Active Alkali, as Na_2O; Per Cent Activity; Sodium Sulphide, as Na_2O; Per Cent Sulphidity; Sodium Sulphate, as Na_2O; Per Cent Reduction; Total Sodium, as Na_2O; Total Sulphur, as S.

On a problem as serious as the sulphate digester corrosion problem, it is only natural that there has been a great deal more talk and trade literature than sound investigation and sound thinking—not only by us in International Paper Co., but also by our competitors, by the steel companies, by the digester fabricators, and by the insurance companies. The items that have perhaps been talked about more than anything else are per cent sulphidity and polysulphides content. I am rather amazed that T 624 m-44 does not give any method for the determination of polysulphides. Most of the people to whom I have talked in our company have just blandly assumed that polysulphides are one of the bad actors in the digester corrosion problem; I, myself, have been one of the people who have been particularly guilty on that point. Therefore, it was a particularly violent intellectual shock when our Mr. Perkins called my attention to a short abstract that appeared on page 76 of the March 10, 1954, issue of *Southern Pulp and Paper Manufacturer*. That specific abstract is under the title of "A Laboratory Approach to the Study of Digester Corrosion" by John W. Hassler, West Virginia Pulp and Paper Co., Tyrone, Pa. For your convenience, I am attaching herewith a copy of the complete abstract appearing on page 76 of the reference just noted. (See below.—Ed.)

I feel sure that you are familiar with the product "synthetic salt cake" that was marketed for a number of years during the World War II era. One of the kraft mills in the United States added said synthetic salt cake for several years in the smelt dissolving tanks instead of into the recovery furnaces. Apparently they obtained excellent results, including at least no noticeable increased corrosion. We, ourselves, resisted the suggestion that International Paper Co. add synthetic salt cake in a similar manner. Our chief objection to using synthetic salt cake in that manner was that we feared that the greatly increased presence of sodium polysulphides and sodium thiosulphate in the digester might increase seriously the corrosion in the digesters, in the multiple effect evaporators, and generally throughout the liquor systems of a sulphate pulp mill.

My present guess regarding the sulphate digester corrosion problem is that probably sodium monosulphide, Na_2S, and sodium hydroxide, NaOH, are the principal bad actors; also that sodium sulphate, Na_2SO_4, and sodium polysulphide, Na_2Sn, are important corrosion inhibitors; also that black liquor organic matter may be the most important corrosion inhibitor. So far as black liquor organic matter is concerned, it seems obvious that the trend toward the use of rotary vacuum filters for sulphate pulp washing, the increased multiple effect evaporator capacities installed in most United States and Canadian mills, and the resulting reduction in the losses of black liquor in the sewer have resulted in black liquor of much lower total solids and organic matter concentration being added to the digesters for cooking.

I have called the above thoughts to your particular attention because I feel very strongly that when spelling out the details of a TAPPI Standard, all of us are prone not to see the woods for the trees; we are apt to lay too much stress on making sure that our official method agrees with somebody else's official method and not enough on hewing to the line with the idea of putting first things first and bringing out the really significant fact or facts that may be significant. It would be "nice," of course, if everybody in the alkali pulping industry did use the same standard terms and the same methods of analysis; but what has been customary in these connections for many years in the United States certainly should not be disregarded arbitrarily in order to satisfy a few "desk" chemists. I myself, have been a "desk" chemist since September, 1942 but, after all, I did spend the years 1923–37 in the laboratory, the years 1937–39 in direct charge of a pulp mill, and the years 1939–42 in immediate charge of our Georgetown, S. C., mill.

A. W. Pesch, *International Paper Co. Southern Kraft Div., Mobile, Ala.*

"A Laboratory Approach to the Study of Digester Corrosion," by John W. Hassler, West Virginia Pulp and Paper Co., Tyrone, Pa.

The corrosion experiments were conducted in glassware and in laboratory steel digesters. Weight losses of firebox steel immersed in cooking liquors provide the basic data which are supplemented by electrochemical measurements.

Results are not always reproducible. Some experiments had to be repeated scores of times in order to have a statistical basis on which to form conclusions.

Some conditions make the surface of steel more resistant to corrosion in alkaline liquors containing sulphidity. Such a surface state is called inert (passive would be a more descriptive term but inert is used here because of a definite relation to liquors containing sulphidity) as distinguished from a more active surface that corrodes readily.

Corrosive attack is minimized by establishing an inert surface on steel and then providing conditions that keep it inert. Unfortunately an inert surface is very easily converted to an active form. Thus, traces of nascent hydrogen released in the corrosion reaction can catalyze this conversion.

Polysulphides are one of the most dependable agents for stabilizing a surface. Corrosion is negligible when polysulphides constitute the major portion of the sulphidity. Small concentrations are less effective and in some cases can even be detrimental.

Straight kraft liquors are very corrosive but this corrosion is greatly reduced when wood chips are present. Several factors contribute to the reduced corrosion: (1) the reaction with wood depletes the concentration of active chemicals, (2) when direct steam heat is used, the condensate dilutes the chemical concentration, and (3) black liquor constituents aid in stabilizing an inert steel surface.

If full advantage can be taken of these factors, and if the laboratory digester surface is an inert state at the start of a cook, then the corrosion is usually less than 15 i.p.y. However, even though every known precaution is taken, occasionally cooks will show an i.p.y. from 50 to 100.

To the Editor, *Tappi:*

I am writing regarding the proposed revision of TAPPI Standard O 400 p-44, Standard Terms Used in the Sulphate Pulping Process, and the points raised in Mr. Pesch's letter.

While I was on the TAPPI Alkaline Pulping Committee, I was chairman of the subcommittee assigned the task of working up this revision. I am no longer on the committee and my following statements do not represent any official com-

ment of the committee, but rather a first-hand account of the developments of the points at issue in the proposed revision.

Historical. Following considerable discussion and correspondence over a period of time regarding a revision of TAPPI Standard O 400 p-44, the TAPPI Alkaline Pulping Committee at its annual meeting in February, 1952, assigned a subcommittee the responsibility for such a revision. A review was made of all previous suggestions and comments. In December, 1952, a survey was made through the New York office of TAPPI of all sulphate mills in the United States and Canada on the most controversial point, namely, whether to base sulphidity on active or total alkali. On the basis of these studies and returns, a revision was submitted to the TAPPI Alkaline Pulping Committee on Jan. 9, 1953. It also was submitted to the Canadian Alkaline Pulping Committee for their information and comment. Although their comments and suggestions were duly noted, they were not given official status.

A second revision was submitted to the TAPPI Alkaline Pulping Committee on May 20, 1953. This revision incorporated the ideas and suggestions of both the TAPPI and Canadian Alkaline Pulping Committees, and the results of the industry survey. This second revision was approved by the TAPPI Alkaline Pulping Committee 172, and was substantially the same as published in the November, 1953, issue of Tappi, page 170A.

The viewpoint of the Alkaline Pulping Committee was that this revision was not considered to be perfect, but did represent the best composite of opinion presently available. Strongly divergent opinions, of course, were expressed on a number of points. I know you will appreciate that the committee had to take into account viewpoints which were just the opposite of Mr. Pesch's, and which were just as positive and sincere.

The most controversial point, of course, was the question of whether to have sulphidity on active or total alkali. Of 31 United States companies which answered the questionnaire on this point most ($22^1/_2$ vs. $8^1/_2$) said they presently were basing this on total alkali, per the old TAPPI Standard. However, these same companies indicated about two to one (20 vs. 11) that they would prefer to base it on active alkali. Our TAPPI Alkaline Pulping Committee also expressed preference for the active alkali basis (as did the Canadian Alkaline Pulping Committee) so a change was made in the proposed revision to the active alkali basis, to represent what appeared to be the definite preference of the industry and its technical people.

On this point of sulphidity, the industry was canvassed by a letter and questionnaire from the national TAPPI office on Dec. 10, 1952. This letter explained that "if there is a preponderance of opinion in the industry favoring either of the methods of expressing sulphidity and causticity, it is proposed that the standard terms be defined accordingly to be realistic."

Discussion of Points Raised

I will comment as best I can on the points raised on pages 70A and 72A of the June, 1954, issue of *Tappi.*

1. *Total Chemical.* It is pointed out that this term includes chemicals such as NaCl which are not available for pulping. My understanding is that it is supposed to do so, that this is what distinguishes "total chemical" from the next term, "total alkali." "Total chemical," as distinguished from "total alkali" will show a mill how much inert chemical it has riding around the system, if it wishes to so determine.

2. *Total Alkali.* It is asked: "should $^1/_2Na_2SO_3$ be Na_2SO_4." The answer is "no" and the explanation is the following comment offered to the Alkaline Pulping Committee along with the revision:

"Dropped Na_2SO_4 on grounds it is not alkali, and added $^1/_2Na_2SO_3$ because approximately half of any Na_2SO_3 is included in usual titration to methyl orange end point for total alkali. See TAPPI Standard T 624, also article by D. R. Moltzau in *Tech. Assoc. Papers* 25: 391–395, 1942. These changes, favored by TAPPI (8-1) and CPPA (13-2), eliminate need for separate term Total Titratable Alkali, and it has been dropped.

3. *Active Alkali.* It is asked why the term "one-half Na_2SO_3" is not included under this item. It was excluded, along with Na_2CO_3, because neither are *active* pulping chemicals in the sense that NaOH and Na_2S are.

6. *Causticizing Efficiency.* Objections are made to the effect that hydrolysis of Na_2S is not taken into account. In preparing our revised definition of this item, we recognized a viewpoint expressed in an article "Some Aspects of the Double Titration Control Test with Respect to Causticizing Efficiency Evaluation," by Peter B. Borlew, *Southern Pulp and Paper Manufacture,* Nov. 10, 1952. This article takes note of some prior articles, including those cited. While Na_2S in cooking liquor undoubtedly does hydrolyze, we believe that substantially all of it titrates as Na_2S in the usual acidimetric, double end-point method of analysis. We say this because our experience is that mill white liquor gives substantially the same sulphide content by both acidimetric (double end point) and idiometric analyses. If a substantial amount existed as NaHS at the time of acid titration, this would no longer be true.

7. *Causticity.* Our surveys indicated that this term is used very little. Most answers were noncommittal. It was the feeling that if used, it should parallel sulphidity.

8. *Sulphidity.* As previously explained, this was changed to the active alkali basis to conform to the majority preference of industry, as well as we were able to determine. It should be emphasized that the change was not a whim of the committee.

We recognize that there will be mills (possibly including our own) which will continue to base sulphidity on total alkali, regardless of any change made in the TAPPI Standard. However, it does appear to be what the industry prefers and is working toward.

10. *Unreduced Salt Cake.* The point is raised of making allowance for Na_2SO_4 introduced in the form of white liquor wash liquors, etc. Don't you think this is taken care of in Note 2 of the Standard, which reads: "In the calculations based upon green liquor, the analysis should be corrected for the content of the weak liquor usually used in dissolving the melt?"

11. *Make-up Chemical Consumption.* The point is well taken, regarding the failure to account for sulphur along with sodium. While it is possible to determine total sulphur, there presently are not methods which will accurately give the various forms of sulphur in the way which we are able to determine the various forms of sodium. Equilibrium shifts in sulphur compounds during analysis by existing methods give false viewpoints, in our experience. The committee recognized this situation by the following note in the proposed revision: "Sulphur and calcium are recognized as important process chemicals, but are not included in the Standard because procedures for their analysis and/or material accounting have not been as well established."

General. The matter of uniformity with CPPA and foreign organizations is raised. This is a worthy goal, which has been recognized by the Alkaline Pulping Committee over the years. The committee approached this goal as far as presently possible by acquainting CPPA with all of its actions in the current revision, studying their comments, and incorporating any which the committee found consistent with its viewpoint.

Summary

To reiterate, the proposed revision consists of majority viewpoints of many people, obtained by procedures representing the most constructive approach that the committee could

devise. The proposed revision obviously does not represent the viewpoint of all people on all points. It is just as obvious that any standard method which tries to incorporate all viewpoints will be no method at all.

I think it is safe to say that the Alkaline Pulping Committee would welcome any constructive comments and suggestions regarding the Standard which might lead to improvements. At the same time, it should be recognized that the Committee may be confronted with diverse and contrary viewpoints, which it must recognize and try to reconcile.

W. P. Lawrence, *Champion Paper & Fibre Co. Hamilton, Ohio*

To the Editor, *Tappi:*

I wish to congratulate Mr. Lawrence on the thorough and clear way in which he has presented his views on the points raised in Mr. Pesch's letter.

I think Mr. Lawrence's letter has gone far toward clearing up the matter and, taking everything into consideration, I believe the revision should be accepted and included in the next looseleaf printing. This, of course, does not prevent further consideration by the Alkaline Pulping Committee and submission of further revisions if they should be considered advisable.

Roger C. Griffin, *Chairman Standards Committee*

RECENT BOOKS

Techniques of Plant Maintenance and Engineering 1954. Clapp & Poliak, Inc., 341 Madison Ave., New York. Cloth, $8^1/_2 \times 11$, 291 pages. $7.50.

This volume is the fifth in a series reporting the proceedings of the technical sessions held concurrently with the Fifth National Plant Maintenance and Engineering held in Chicago in January, 1954. It includes the prepared papers presented and discussions at the 20 round-table meetings.

Among the subjects covered are the following: Planning and Scheduling Maintenance Work, Preventive Maintenance, Training, Sanitation, Work Measurement, Corrosion Control and Prevention, Hospitals and First-Aid Rooms, Waste Disposal, and Cost Control and Budgeting.

There is included a report of the Paper Mills and Paper Products Plants Round Table which was led by Warren Henricks of The Mead Corp.

American Chemical Industry, Vols. 1–6. By William Haynes. D. Van Nostrand Co., New York, 1954. Cloth, $6^1/_2 \times 9^1/_2$; each volume averages 550 pages. $15 per volume.

As one of the principal uses of chemical materials the executives of the pulp and paper industry should be interested in this remarkable work by William Haynes, famous chemical magazine editor. It traces in detail the development of chemical manufacturing in America from Colonial until modern times. Each volume covers a particular period of time or important phase of chemical progress, including products, processes, methods, and the men and companies who played important parts in the industry's growth.

Volume I ($15) covers Background and Beginnings 1608 to 1910 featuring the colonies, forest products, chemical pioneering, early acid makers, and the first synthetic chemical and naval stores.

Volume II ($15) covers the Word War I Period, 1912 to 1922, featuring the Wilsonair background, gearing industry to war, nitrates from Chile, coal by-products, potash, and critical metals.

Volume III ($15) covers the same period featuring caustic, bleach, alums, pigments and colors, alcohols, the dye crisis, and chemicalization of industry.

Volume IV ($15) covers the Merger Era, 1923 to 1929, featuring the return to normalcy, foreign cartels and trusts, acid from brimstone, wood chemicals, American dyes, fine chemicals, plastics and resins, and rayon.

Volume V ($15) covers the Decade of New Products, 1930 to 1939, featuring the introduction to the depression, changing trade channels, contracting world trade, alkalies and chlorine, dyes, industrial gases, petrochemicals, coatings, fibers and fabrics, and broadening chemical markets.

Volume VI ($15) is devoted to the Histories of the Companies (this volume was published in 1949 prior to the printing of the other five volumes). Companies familiar to the paper industry include Allied Chemical & Dye Corp., American Cyanamid Co., American Resinous Chemicals Co., American Viscose Corp., Godfrey L. Cabot, Inc., the Carborundum Co., Celanese Corp. of America, Champion Paper & Fibre Co., Ciba Co., Columbia Chemical Co. Div., Pittsburgh Plate Glass Co., Crosby Chemicals, Inc., Diamond Alkali Co., The Drackett Co., E. I. du Pont de Nemours & Co., Inc., Ecusta Paper Co., Freeport Sulphur Co., General Dyestuff Corp., General Electric Co., The Glidden Co., Goodyear Tire & Rubber Co., Hercules Powder Co., Hooker Electrochemical Co., Interchemical Corp., Johns-Manville Corp., Mallinckrodt Chemical Corp., Monsanto Chemical Co., National Aluminate Corp., National Aniline Div., Nopco Chemical Co., Pennsylvania Salt Mfg. Co., Reichhold Chemicals, Inc., Sandoz Chemical Works, Rohm & Haas Co., Solvay Process Co., Texas Gulf Sulphur Co., Titanium Pigment Co., and Wyandotte Chemicals Corp., all company members of the Technical Association of the Pulp and Paper Industry.

ASTM Standards on Wood, Wood Preservatives and Related Materials. Sponsored by ASTM Committee D-7 on Wood. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1954. Paper cover, 6×9, 356 pages. $3.75.

From time to time the ASTM brings together in one volume its testing procedures on related subjects. The present volume covers such subjects as: Methods for evaluating the mechanical and physical properties of wood, plywood and fiber building boards; Methods for chemical analysis of wood (ash, alpha-cellulose, holocellulose, lignin, methoxyl groups, alcohol-benzene solubility, ether solubility, one per cent caustic soda solubility, and water solubility; Definitions of terms relating to wood; Methods of structural grading and specifications for wood and timbers; Fire tests of building materials and construction; and wood preservatives.

Note: Books reviewed in this column may be obtained from the Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

EMPLOYMENT SERVICE

Positions Wanted

E280-54. Technical graduate, 32, 7 years' broad experience in research, development, technical control, and some fourdrinier operating. Particularly qualified on technical control for kraft mill pulping and fine, wrapping, and specialty fourdrinier manufacture. Can take complete charge of technical department and have several years' experience at same. Seeks responsible operating or technical job as technical director or superintendent of a small mill or assistant in larger one.

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E282-54. Graduate Chemical Engineer. Seventeen years' varied experience in sales and product development. Opportunity primary concern.

E283-54. Pulp Mill Superintendent; college degree. Broad background in chemistry, 18 years' operating experience, excellent production, safety, maintenance, and industrial relations record. Desires responsible position with progressive pulp mill, preferably in the South or Southwest.

E284-54. Graduate Mechanical Engineer, 1949, with 2 years' experience in development and engineering in the chemical industry, 1 year in control and maintenance in a large newsprint mill, and 2 years' production supervision in plastics fabrication. Interested in production, control, or development.

E285-54. Certified Public Accountant (New Jersey), mature, with varied experience, wishes employment with American company with headquarters in England, on long term basis. Willing to travel in Europe.

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P394-54. Project Supervisor. We are seeking a man with a papermaking background received either through training or experience who has not only imagination but a certain amount of inquisitiveness and who might be interested in rather an unusual position. Will you write us in detail?

P395-54. College graduate with B.S. degree in Chemical Engineering or Pulp and Paper Technology to work in large New England integrated paper mill. Previous experience desirable but not necessary. Responsible position with excellent opportunity for advancement.

P396-54. Technical Salesman: Manufacturing and importing concern desires a salesman under 40 years of age to sell basic materials and chemical specialties to the paper industry. Qualifications must include a chemical background and technical or production experience in the paper industry. Applicants must be free to locate in the Chicago-Detroit area. Send complete information on education, experience, and salary desired. All replies confidential.

P397-54. Chemical Engineer or Chemist, 25 to 35, pulp and paper process experience preferable but not required, to work on technical staff of semichemical pulp and paper mill in midwest. All replies confidential.

P398-59. Project Engineer with creative aptitudes for paper machinery development—New England area. Applicant must be somewhat of a physicist who can readily apply fundamental laws of thermodynamics, heat transfer, fluid dynamics, and applied mechanics to creative work. He must be able to think in terms of and perform simple experiments for verifying ideas. He will be expected to make design layouts and specifications for subsequent detailing and manufacture. High-speed paper machine design or operating experience is desired but not essential. This is a real opportunity for the young engineer who wants to play an important part in a fast growing industry. Salary will be commensurate with experience. Applicants to enclose photograph with complete résumé of educational and industrial backgrounds including present salary and salary expected. All applications will be acknowledged, and will be held in strict confidence.

P399-54. Chemist or Chemical Engineer with pulp and paper experience for integrated mill in southeastern section of United States. Must have training in the organization and functions of technical programs. Please reply giving education, experience, personal data, references, and salary expected. All replies will be held in strictest confidence.

P400-54. Immediate Opening with Opportunity. Improved Caseins for the Paper Industry. Program: Sales Development Laboratory is designing program for work on improved caseins to achieve tailor-made applications pertinent to the industry. Assignment: Selected person must be able to carry these special casein applications through development and introduce same to the paper industry. Qualifications: Graduate Chemist or Chemical Engineer with personality and bearing enabling person to converse and work with all levels of paper industry personnel. Experience: In paper coating field with good knowledge of laboratory techniques and familiarity with paper coating equipment and processes. Salary commensurate with ability. Write To: The Borden Co., Chemical Div., Bainbridge, N. Y., Attention, Personnel Office. Complete résumé giving past, present, and expected salary.

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Excellent opportunity with a large progressive chemical company for an agressive individual capable of introducing new chemicals and resins to the paper industry. Five to ten years' experience in paper converting required—sales experience desirable—paper schooling graduate preferred. Write giving résumé of education, experience, personal data, and salary desired. All replies remain confidential. Direct all replies to P401-54.

402-54. Wanted: Mechanical Engineer, 25 to 35, to be Assistant to Production Manager of small specialty paper mill in New England. Some experience as manufacturing or maintenance supervisor desirable. Forward complete résumé of personal history, education, and experience with introductory letter.

Note: Responses to all advertisements should, unless otherwise indicated, be sent to TAPPI, 155 E. 44th St., New York 17, N. Y.

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THE LITERATURE OF CELLULOSE AND OTHER MATERIALS RELATED TO THE PULP AND PAPER INDUSTRY*

Introduction

HARRY F. LEWIS

We are privileged to present before the joint meeting of the Division of Cellulose Chemistry and Chemical Literature of the American Chemical Society this symposium on The Literature of Cellulose and Other Materials Related to the Pulp and Paper Industry.

In a very real sense, this symposium may be looked upon as a memorial to Dr. C. J. West, Editor of The Institute of Paper Chemistry and internationally known bibliographer, who died Jan. 29, 1953. Dr. West's contribution to this field will be recited frequently by the symposium speakers. These contributions were recognized as far back as 1937 when he was awarded the Gold Medal of the Technical Association of the Pulp and Paper Industry [*Tech. Assoc. Papers* 20: 84–86, 1937] given to those whose achievements have definitely contributed to the technical progress of the pulp and paper industry. From 1920 until his death, he had been chairman of the TAPPI Committee on Abstracts and Bibliography. As Editor of The Institute of Paper Chemistry, Dr. West was responsible for editing all technical and scientific publications of the Institute and for the preparation of its technical bibliographies.

The first four papers on the program will provide a complete listing of the literature in its various phases. W. M. Hearon of the Central Research Department of the Crown Zellerbach Corp. will survey the various periodicals; C. L. Brown, Prevention of Deterioration Center of the National Research Council, will list the abstracting services which relate to the field; E. C. Jahn, State University of New York, College of Forestry, is describing the available books and reference works, and Jack Weiner, The Institute of Paper Chemistry, will present the numerous bibliographies. The material prepared in these four reports will provide invaluable aid to those concerned with research and development as well as with production and management of the cellulose, wood, and pulp and paper industries.

How this all developed historically will be covered by L. F. McBurney and Herman Skolnik of the Hercules Experiment Station, Hercules Powder Co. G. J. C. Potter of the Pulp and Paper Research Institute of Canada will describe the path to be followed by the searcher as he attempts to use these various bibliographic tools.

The symposium will be closed by E. J. Crane, Editor of *Chemical Abstracts*, who will pay personal tribute to Dr. West.

The chairman wishes to express his thanks to the symposium speakers for their valuable contributions, to the Divisions of the American Chemical Society who have provided the forum, and to the Technical Association of the Pulp and Paper Industry in whose journal, *Tappi*, this symposium is appearing.

Harry F. Lewis, Symposium Chairman, The Institute of Paper Chemistry, Appleton, Wis.

* A Symposium at the 1954 Spring Meeting of the American Chemical Society, Kansas City, Mo., March 29, 1954.

The Literature of Cellulose and Related Materials

W. M. HEARON

In discussing such a broad subject as the literature of cellulose and related materials, it is necessary to settle on certain definitions. First, by literature, we mean all publications other than books. The remainder still represents a wide field but the majority of publications are papers which appear in periodicals. There are, however, important publications by industrial companies in the form of technical data sheets, bulletins, or house organs. Then for the sake of completeness, we should add as publication media, student theses, and patents although these generally are published also as articles in the periodicals.

Cellulose is a fairly specific subject. Perhaps you would say at first glance, very specific. However, we have so-called alpha, beta, and gamma-cellulose and we have cellulose in many forms: rayon, raw cotton, wood pulp, and its many converted forms such as cloth, paper, surgical dressings, wadding, and so forth.

As for "related materials," we have an even more complex picture. Obviously chemical cellulose derivatives—nitrates, acetates, mixed esters, ethers, carboxymethyl cellulose, hydroxyethyl cellulose—are related to cellulose. However, is lignin related to cellulose? It occurs simultaneously with cellulose wherever the latter is found and there is even some evidence of a lignin-cellulose bond in nature. How about wood and plant extractives? Are they related to cellulose?

To further complicate the situation, where does literature end and advertising start?

Obviously, considering time and effort limitations, some restrictions are needed in this subject. Here they are. I shall discuss the literature of cellulose in its various forms (cotton, pulp, rayon, etc.) but not as converted products (paper, cloth, etc.). I shall include, of course, the literature of cellulose chemical derivatives. The problem of what related materials to include has already been considered by *Chemical Abstracts* and I shall abide by their decision to include those materials which are found in Section 23 of *Chemical Abstracts*, which includes besides those mentioned above, hemicelluloses, pentosans, and lignin. I shall include as literature those publications other than books which present technical information.

At the present time, there are no journals devoted exclusively to cellulose or its related materials. The only journal approaching this is the *Journal of the Society of Textile and Cellulose Industry (Japan)*. It, however, is printed in Japanese and does not have a wide circulation. In the past, however, there have been journals devoted to cellulose and some have been of high quality. *Cellulosechemie* was started in 1920 by Emil Heuser, in Germany, and was published irregularly until 1944. It contains many fine articles on all

W. M. Hearon, Crown Zellerbach Corp., Camas, Wash.

types of cellulose research. The journal *Cellulose*, an American publication, lasted only for the year 1930. The German journal, *Nitrocellulose*, a monthly publication survived somewhat better and lasted from 1930 to 1943. It contains worthwhile articles on its own specific form of cellulose. The Japanese *Journal of the Cellulose Institute* was published monthly from 1925 to 1943. After that time the articles were apparently published in the above-mentioned *Journal of the Society of Textile and Cellulose Industry (Japan)*. These journals are summarized in Table I.

Table I. Journals Publishing Cellulose Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Cellulose	American	Monthly	Jan., 1930	Dec., 1930
Cellulosechemie	German	Monthly	1920	1944
Nitrocellulose	German	Monthly	1930	1943
Cellulose Industry (Journal of the Cellulose Institute, Tokyo)	Japanese	Monthly	1925	1943

Table II. Journals Publishing Organic Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Journal of the American Chemical Society	American	Semimonthly	1876	to date
Journal of Organic Chemistry	American	Monthly	1936	to date
Tappi (formerly Technical Association Papers)	American	Monthly	1918	to date
Journal of the Chemical Society (London)	British	Monthly	1841	to date
Canadian Journal of Chemistry	Canadian	Monthly	1929	to date
Chemische Berichte	German	Monthly	1868	to date
Annalen (Justus Liebig's Annalen der Chemie)	German	Irregular	1832	to date
Journal für präktische Chemie	German	Irregular	1834	1943
Fortschritte der Chemie, Physik und physikalischen Chemie	German	Irregular	...	1932
Bulletin de la societe chimique de France	French	Monthly	1858	to date
Comptes rendus	French	Weekly	1835	to date
Australian Journal of Chemistry (formerly Australian Journal of Scientific Research, Series A, Physical Sciences)	Australian	Quarterly	1948	to date
Monatshefte für Chemie	Austrian	Quarterly	1880	to date
Receuil des travaux chimiques des Pays-Bas	Dutch	Monthly	1882	to date
Annali di chimica (Rome) (formerly Annali di chimica applicata)	Italian	Monthly	1914	to date
Bulletin of the Chemical Society of Japan	Japanese	Bimonthly	1928	to date
Bulletin of the Institute for Chemical Research, Kyoto University	Japanese	Quarterly	1928	to date
Journal of the Chemical Society of Japan (since 1948 divided into two sections) Pure Chem. Section	Japanese	Monthly	...	to date
Acta Chemica Scandinavica	Scandinavian	10 numbers a year	1947	to date
Svensk Kemisk Tidskrift	Swedish	Monthly	1889	to date
Helvetica Chimica Acta	Swiss	6 to 8 numbers a year	1918	to date
Makromolekulare Chemie	Swiss	Quarterly	1947	to date

Table III. Journals Publishing Physical Chemistry Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Journal of the American Chemical Society	American	Semimonthly	1876	to date
Journal of Colloid Science	American	Bimonthly	1946	to date
Journal of Chemical Physics	American	Monthly	1933	to date
Journal of Polymer Science	American	Monthly	1946	to date
Journal of Physical Chemistry	American	Monthly (except July, Aug., Sept.)	1896	to date
Journal of Applied Physics	American	Monthly	1930	to date
Journal of the Chemical Society (London)	British	Monthly	1841	to date
Canadian Journal of Chemistry	Canadian	Monthly	1929	to date
Fortschritte der Chemie, Physik und physikalischen Chemie	German	Irregular	...	1932
Kolloid-Zeitschrift	German	Monthly	1906	to date
Zeitschrift für physikalische Chemie	German	6 numbers a year	1887	to date
Bulletin de la societe chimique de France	French	Monthly	1858	to date
Journal of Scientific and Industrial Research (India)	Indian	Monthly	1942	to date
Bulletin of the Chemical Society of Japan	Japanese	Bimonthly	1928	to date
Colloid Journal (U.S.S.R.) (Kolloidnyi Zhurnal)	Russian	Bimonthly	1935	to date
Helvetica Chimica Acta	Swiss	6 to 8 numbers a year	1918	to date
Makromolekulare Chemie	Swiss	Quarterly	1947	to date

Table IV. Journals Publishing Analytical Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Analytical Chemistry	American	Monthly	1929	to date
Tappi (formerly Technical Association Papers)	American	Monthly	1918	to date
The Biochemical Journal (London)	British	Monthly	1906	to date
Journal of the Chemical Society (London)	British	Monthly	1841	to date
Journal of the Society of Dyers and Colourists	British	Monthly	1884	to date
Das Papier	German	Monthly	1947	to date
Zeitschrift für anorganische und allgemeine Chemie	German	Bimonthly	1892	to date
Mikrochemie vereinigt mit Mikrochimica Acta	Austrian	Irregular	1923	to date
Zhurnal Analiticheskoi Khimii (Journal of Analytical Chemistry)	Russian	Bimonthly	1946	to date

Because there are no journals now exclusively devoted to articles on cellulose, people have resorted to publishing in the standard chemical journals. There are, of course, many types of cellulose work—organic, physical, industrial, and so forth, and where these articles appear depends upon the type of work. For this reason, it is difficult to analyze a large number of journals and discuss the type of cellulose articles which might appear.

Another way to survey the literature of cellulose and related materials is to consider where one might publish his

Table V. Journals Publishing Industrial Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Industrial and Engineering Chemistry	American	Monthly	1909	to date
Chemical Engineering	American	Monthly	1903	to date
Journal of Applied Chemistry (London) (formerly Journal of the Society of Chemical Industry)	British	Monthly	1882	to date
Chemistry and Industry	British	Weekly	1882	to date
Canadian Chemical Processing (formerly Canadian Chemistry and Process Industries)	Canadian	Monthly	1917	to date
Angewandte Chemie (formerly Zeitschrift für angewandte Chemie)	German	Semimonthly	1888	to date
Chemische Technik, Die (Berlin)	German	Monthly	1949	to date
Zeitschrift des Vereines deutscher Ingenieure	German	About 3 times a month	...	to date
Australian Journal of Applied Science (continuation of Journal of the Council for Scientific and Industrial Research)	Australian	Quarterly	1950	to date
Journal of the Chemical Society of Japan (since 1948 divided into two sections) Industrial Chemistry Section	Japanese	Monthly	...	to date

Table VIA. Journals Publishing Pulp and Paper Articles—Scientific and Technical

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Cellulose	American	Monthly	Jan., 1930	Dec., 1930
Tappi (formerly Technical Association Papers)	American	Monthly	1918	to date
British Paper and Board Makers' Association, Technical Section—Proceedings Tech. Bull.	British	2 or 3 numbers a year	1921	to date
Technical Bulletin	British	6 numbers a year	1921	to date
Journal of the Textile Institute	British	Monthly	1910	to date
World's Paper Trade Review	British	Weekly	1879	to date
Canadian Pulp and Paper Association Technical Section Proceedings	Canadian	Annual	1915	to date
Cellulosechemie	German	Monthly	1920	1944
Faserforschung; Zeitschrift für Wissenschaft und Technik der Faserpflanzen	German	Quarterly	1921	1944
Holz als Roh- und Werkstoff	German	Monthly	1937	to date
Holzforschung	German	Irregular	1947	to date
Das Papier	German	Monthly	1947	to date
Allgemeine Papier-Rundschau (formerly Papier-Zeitung)	German	Monthly	1921	to date
Papier-Fabrikant	German	Weekly	1902	1944
Papier und Druck	German	Monthly	1952	to date
Pappen-Zeitung und Holzstoff-Zeitung (issued as part of Kartonnagen und Papierwaren-Zeitung, 1937 to 1941)	German	...	1895	1936
Technologie und Chemie der Papier-und Zellstoff Fabrikation (published with Wochenblatt für Papierfabrikation, 1928 to 1934)	German	Irregular	1892	1939
Wochenblatt für Papierfabrikation	German	Biweekly	1870	to date
Zellstoff-Faser	German	Irregular	1904	1936
Association technique de l'industrie papetiere, Bulletin	French	Irregular	1947	to date
L'Industrie Papetiere	French	Monthly	1922	to date
Moniteur de la papeterie francaise	French	Monthly	1863	to date
La Papeterie	French	Monthly	1878	to date
Le Papier	French	Monthly	1898	1944
Technologie de l'Imprimerie	French	...	1933	1939
Australian Pulp and Paper Industry Technical Section Proceedings	Australian	Annual	1947	to date
Zeitschrift für Papier, Pappe, Zellulose und Holzstoff (1st 36 volumes 1883–1919 as Zentralblatt für die Österreich-Ungarische Papierindustrie; Volumes 37–55, 1919–1937 as Zentralblatt für die Papierindustrie)	Austrian	...	1883	1937
Zentralblatt für die Österreich-Ungarische Papierindustrie (see Zeitschrift für Papier, Pappe, Zellulose und Holzstoff	Austrian	...	1883	1918
Moniteur de la papeterie belge	Belgian	Monthly	1921	1940
Paperi ja Puu (Paper and Timber)	Finnish	Monthly	1921	to date
Finsk Pappers- och Travarutidskrift (became Pappers-, Travaru- och Industritidskrift för Finland in 1921)	Finnish	...	1919	1920
Pappers-, Travaru- och Industritidskrift för Finland (see Finsk Pappers- och Travarutidskrift, and Paperi ja Puu)	Finnish	...	1921	1949
Indian Pulp and Paper	Indian	Monthly	1947	to date
Bollettino della regia stazione sperimentale per l'industria della carta e lo studio delle fibre tessili vegetali (now absorbed in "L'Industria della carta," which see)	Italian	...	1922	1933
Industria della carta, L' (Milan)	Italian	Monthly	1934	to date
Cellulose Industry (Journal of the Cellulose Institute, Tokyo)	Japanese	Monthly	1925	1943
Norsk Skogindustri (formerly Papir-Journalen)	Norwegian	Monthly	1947	to date
Papir-Journalen (superseded by Norsk Skogindustri, 1947 to date)	Norwegian	Semimonthly	1913	1946
Przeglad Papierniczy (The Polish Paper Review)	Polish	Monthly	1944	to date
Bumazhnaya Promyshlennost (Paper Industry)	Russian	Bimonthly	1922	to date
Acta Chemica Scandinavica	Scandinavian	10 numbers a year	1947	to date
Svensk Papperstidning (Swedish Paper Journal)	Swedish	Semimonthly	1898	to date

work and I shall follow that procedure. For the sake of completeness, however, many other possible places for publication will be listed in the tables.

Let's suppose that you have written a paper on preparing the trifluoroacetate esters of cellulose and have studied their hydrolysis. This is a straightforward organic problem and if you lived in America you would probably submit the paper to the *Journal of American Chemical Society* or the *Journal of Organic Chemistry*, both of which are very fine journals. If, however, you felt that your work did not meet the rigid standards of these journals, you might submit your paper to *Science*, a publication of the American Association for the Advancement of Science. If you lived in England, you would probably send your paper to the *Journal of the Chemical Society*, which is of similar quality to the *Journal of the American Chemical Society*. If again you did not believe that your paper met the requirements of the Society's journal, you might send it to *Nature*, which parallels our magazine, *Science*. In Germany, you might send your paper to the very excellent *Chemische Berichte* or in France to the *Bulletin de la societe chimique de France*. Of course, there are many other places you could send your paper and these are listed in Table II.

Instead of doing synthetic work, suppose you had measured the rheological properties of cellulose propionate films. This is clearly a problem in physical chemistry. You might send it to the *Journal of the American Chemical Society* or if you wished to publish in a journal devoted exclusively to your type of work you would send it to the *Journal of Physical Chemistry* or the *Journal of Polymer Science*. Both of these journals are of high quality. In England, you would probably send it to the *Journal of the Chemical Society* and in Germany to the *Zeitschrift für physikalische Chemie*. There are a number of other journals that you could patronize and they will be found in Table III.

If your work covered analyses of cellulose or its derivatives you would undoubtedly submit it in America to the excellent journal, *Analytical Chemistry* (before 1947 known as the *Analytical Edition of Industrial and Engineering Chemistry*). In England you would again send your article to the *Journal of the Chemical Society* and in Germany perhaps to the *Zeitschrift für anorganische und allgemeine Chemie*. Table IV summarizes the probable locations for finding analytical articles on cellulose materials.

If you are an American chemical engineer and have prepared a paper on a process concerned with cellulose or its related materials, you would undoubtedly send your article to either *Industrial and Engineering Chemistry* or the journal, *Chemical Engineering*. Both of these are very excellent publications. In England you would probably submit your paper to the *Journal of Applied Chemistry* (which was formerly known as the *Journal of the Society of Chemical Industry*) or to the journal, *Chemistry and Industry*. These are also ex-

Table VIB. Journals Publishing Pulp and Paper Articles—Trade

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
American Boxmaker	American	13 numbers a year	1910	to date
American Paper Converter (see Paper, Film and Foil Converter)	...	...	...	...
American Paper Merchant	American	Monthly	1920	to date
Box Maker	American	...	1892	1917
Boxboard (superseded by Fibre Containers, which see)	American	...	1922	1932
Boxboard Containers (formerly Shears)	American	Monthly	1892	to date
Converter (see Paper, Film and Foil Converter)	...	...	...	...
Fibre Containers (see Fibre Containers and Paper Board Mills)	...	...	...	...
Fibre Containers and Paper Board Mills (formerly Fibre Containers)	American	Monthly	1916	to date
Modern Packaging	American	Monthly	1927	to date
Pacific Pulp and Paper Industry (see Pulp and Paper)	...	...	...	...
Paper and Paper Products	American	Semimonthly	1884	to date
Paper and Twine Journal	American	Monthly	1927	to date
Paper Box Maker (formerly Paper Box Maker and American Book Binder)	American	...	1892	1919
Paper, Film and Foil Converter (formerly Converter, then American Paper Converter)	American	Monthly	1927	to date
Paper Industry (formerly Paper Industry and Paper World)	American	Monthly	1919	to date
Paper Mill News (formerly Paper Mill and Wood Pulp News)	American	Weekly	1876	to date
Paper Trade Journal	American	Weekly	1872	to date
Paper World (combined with Paper Industry, 1938 to form Paper Industry and Paper World; now Paper Industry, which see)	...	...	...	...
Pulp and Paper (formerly Pacific Pulp and Paper Industry)	American	Monthly	1927	to date
Southern Pulp and Paper Manufacturer (formerly Southern Pulp and Paper Journal)	American	Monthly	1938	to date
Box Maker's Journal and Packaging Review	British	...	1897	to date
British Paper	British	...	1933	to date
Fibreboard Containers	British	...	1934	to date
Paper and Pulp	British	...	1896	1906
Paper and Print	British	Quarterly	1928	to date
Paper Box and Bag Maker	British	Monthly	1896	to date
Paper Container	British	Monthly	1949	to date
Paper-Maker and British Paper Trade Journal	British	Monthly	1891	to date
Paper Makers' Monthly Journal	British	Monthly	1863	1932
Paper Making and Paper Selling (formerly Paper Making and the Printer)	British	Quarterly	1881	to date
Paper Making and the Printer (merged with Paper and Pulp; see Paper Making and Paper Selling)	...	...	...	...
Canadian Pulp and Paper Industry (formerly Western Pulp and Paper)	Canadian	Monthly	1948	to date
Pulp and Paper Magazine of Canada (formerly Pulp and Paper of Canada)	Canadian	Monthly	1903	to date
Pulp and Paper Mill News	Canadian	...	1937	to date
Pulp and Paper of Canada (see Pulp and Paper Magazine of Canada)	...	...	...	...
German Paper News (English edition of Papier Zeitung)	German	...	1927	1931
Kartonagen und Papierwaren-Zeitung; with supplement Pappen- und Holzstoff-Zeitung (apparently suspended in 1941)	German	...	1897	1941 (?)
Neue Verpackung	German	...	1948	to date
Papier Zeitung	German	Semiweekly	1878	1944
Pappen- und Holzstoff-Zeitung (see Kartonagen und Papierwaren-Zeitung)	...	...	...	...
Papier, Carton et Cellulose	French	...	1952	to date
Finnish Paper and Timber	Finnish	10 numbers a year	1950	to date
Indian Print and Paper	Indian	Quarterly	1934	to date

Table VII. Journals Publishing Textile Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
American Dyestuff Reporter	American	Biweekly	1916	to date
Modern Textiles (formerly Rayon and Synthetic Textiles)	American	Monthly	1925	to date
Proceedings of the American Association of Textile Chemists and Colorists (Published in American Dyestuff Reporter, which see)	...	...	...	...
Textile Age	American	Monthly	1937	to date
Textile Research Journal	American	Monthly	1930	to date
British Rayon and Silk Journal	British	Monthly	1921	to date
Journal of the Textile Institute	British	Monthly	1910	to date
Textile Manufacturer	British	Monthly	1875	to date
Faserforschung und Textiltechnik	German	Monthly	1951	to date
Melliant Textilberichte (formerly Textilberichte über Wissenschaft, Industrie und Handel)	German	Monthly	1920	to date
Reyon, Zellwolle und andere Chemiefasern (formerly Reyon, Synthetica, Zellwolle)	German	Monthly	1919	to date
Textilberichte über Wissenschaft, Industrie und Handel (see Melliand Textilberichte)	...	...	...	...
Zeitschrfit für die gesamte Textile-Industrie	German	Semimonthly	...	to date
Bulletin de l'institut textile de France	French	Bimonthly	1929	to date
Rayonne et fibres synthetiques (formerly Rayonne)	Belgian	Monthly	1945	to date
Journal of the Society of Textile and Cellulose Industry (Japan)	Japanese	Monthly	1945	to date
Tekstilnaya Promyshlennost (Textile Industry)	Russian	Monthly	1941	to date

Table VIII. Journals Publishing Wood Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Journal of Forestry	American	Monthly	1917	to date
Journal of the Forest Products Research Society	American	5 numbers a year	1951	to date
Paper Industry (formerly Paper Industry and Paper World)	American	Monthly	1919	to date
Wood and Wood Products	American	Monthly	1946	to date
Forestry	British	Semiannual	1927	to date
Holzforschung	German	Irregular	1947	to date
Holz als Roh- und Werkstoff	German	Monthly	1937	to date
Australian Forest Products Laboratory Reports	Australian	Irregular	...	...
Mitteilungen der österreichischen Gesellschaft für Holzforschung	Austrian	Irregular	1949	to date
Finnish Paper and Timber	Finnish	10 numbers a year	1950	to date
Norsk Skogindustri (formerly Norsk Skogsindustri, before that Papir-Journalen)	Norwegian	Monthly	1947	to date
Latvijas PSR Zinatnu Adademijas Vestis	Russian	Monthly	1950	to date
Zhurnal Prikladnoi Khimii (Journal of Applied Chemistry)	Russian	Monthly	1928	to date
Swedish Timber and Wood Pulp Journal (Svensk Travaru-Tidning; Svensk Papersmasse-Tidning)	Swedish	Semimonthly	1885	to date

Table IX. Journals Publishing Lignin Articles

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Industrial and Engineering Chemistry	American	Monthly	1909	to date
Journal of the American Chemical Society	American	Semimonthly	1876	to date
Journal of Organic Chemistry	American	Monthly	1936	to date
Science	American	Weekly	1883	to date
Tappi (formerly Technical Association Papers)	American	Monthly	1918	to date
Journal of the Chemical Society (London)	British	Monthly	1841	to date
Nature	British	Weekly	1869	to date
Chemische Berichte	German	Monthly	1868	to date
Das Papier	German	Monthly	1947	to date
Papier, Carton et Cellulose	French	...	1952	to date
Monatshefte für Chemie	Austrian	Quarterly	1880	to date
Finnish Paper and Timber	Finnish	10 numbers a year	1950	to date
Bumazhnaya Promyshlennost	Russian	Bimonthly	1922	to date
Zhurnal Obshchei Khimii (Journal of General Chemistry)	Russian	Monthly	1931	to date
Svensk Kemisk Tidskrift	Swedish	Monthly	1889	to date
Svensk Pappers tidning (Swedish Paper Journal)	Swedish	Semimonthly	1898	to date

Table X. Company Magazines

Magazine	*Company*	*Frequency of publication*	*Started*	*Duration*
Dow Diamond	Dow Chemical Co.	Bimonthly	1938	to date
Du Pont Technical Bulletin	Du Pont	Quarterly	About 1920	to date
Du Pont Magazine	Du Pont	Quarterly	1907	to date
Hercules Chemist	Hercules Powder Co.	Irregular	...	...
The Paper-Maker	Hercules Powder Co.	Twice yearly (Feb. & Sept.)	1932	to date
Monsanto Magazine	Monsanto Chemical Co.	Irregular	1921	to date
Rohm and Haas Reporter	Rohm and Haas Co.	Bimonthly	1943	to date

Special Publications

Institute of Paper Chemistry publications
TAPPI Monographs
TAPPI Special Reports
TAPPI Data Sheets
TAPPI Standards and Suggested Methods
U. S. Forest Products Laboratory Reports
Northeastern Wood Utilization Council Bulletins

cellent publications. In Germany, you would probably publish in the leading industrial journal, *Angewandte Chemie*, (formerly known as the *Zeitschrift für angewandte Chemie*). The best industrial journals on cellulose work are listed in Table V.

Although I have mentioned only cellulose in the above discussion, articles on pentosans and hemicelluloses would appear in the same journals except when these materials are associated with pulp.

Cellulose in the form of pulp has a literature all of its own. In general, articles on the related materials from wood such as hemicelluloses, lignins, and pentosans will often also be found in the pulp and paper literature. Some of these journals are of a high scientific caliber while others are only trade journals, and there are degrees in between. In America the most scientific journal in this field is *Tappi* (before 1948, the *Technical Section* of the *Paper Trade Journal*). Here you will find all varieties of papers on pulp and related materials and most of a very good quality. In Canada such publications generally occur in the *Pulp and Paper Magazine of Canada* and the *Canadian Pulp and Paper Association Technical Section Proceedings*. Because of the large amount of work in the paper field in Sweden they have several good journals. The *Acta Chemica Scandinavica*, which has only been published since 1947, is very similar to our own *Tappi*. Before the *Acta Chemica Scandinavica* was published many of the papers were sent to the *Svensk Papperstidning*. In Germany, we have the journal *Das Papier* and in France, *La Papeterie*. However, these are not quite in the class with those previously mentioned. All told, there are many journals publishing some technical articles on pulp and related materials and those will be found in Table VI.

Articles on cellulose in the form of cotton or rayon will be found generally in the *Textile Research Journal* or the British publication, *Journal of the Textile Institute*. See Table VII.

Wood as a raw material for cellulose has its own particular literature. In the United States we have the *Journal of Forestry* but there are other good journals in the countries which have appreciable timber supplies. In Germany, *Holzforschung* is a good journal. Finland has the magazine, *Paper and Timber*. Sweden publishes the *Swedish Timber and Wood Pulp Journal*. A more complete list will be found in Table VIII.

Articles on lignin are found in many of the journals already mentioned. The *Journal of the American Chemical Society* publishes such articles as does *Tappi*. One Austrian journal in the previously mentioned list which contains lignin articles is *Monatshefte für Chemie*. Table IX gives a more complete list.

Besides the journals mentioned above, there are other publications which should be noted. *Chemical Reviews* should not be overlooked as a source of review articles, and *Chemical and Engineering News* often carries survey articles particularly with an economic slant. There are also excellent publications on cellulose and related materials put out by The Institute of Paper Chemistry. These are limited to the Institute's associate members. There are also TAPPI Monographs, Special Reports, Data Sheets, and Standards and Suggested Methods which cover pulp and related materials. The U. S. Forest Products Reports include research on wood and related materials carried out in the Department of Agriculture's, Forest Products Laboratory. Also the Northeastern Wood Utilization Council issues a bulletin on their research.

The chemical companies which produce products from cellulose or wood or who serve the pulp and paper industry issue data sheets and bulletins on their products. These are excellent sources for much technical information. Among these companies are Eastman Kodak, Hercules, Dow, and du Pont. There are also several companies which periodically publish house organs containing information on cellulose and related materials. A list of these will be found in Table X.

Student theses are sometimes concerned with cellulose problems and as such are a source of technical information. Generally, the work is subsequently published in the journals and is most easily found there. Some universities, however, publish lists of their graduate theses in *Chemical and Engineering News*. Most universities are willing to loan a thesis from their library for a short time.

Patents are also a source of technical information on cellulose and related materials. Some of the work covered by patents also appears in the journals, which is often an easier source for the information. U. S. patent classifications 260-212 to 260-233 are concerned with cellulose and classification 260-124 is concerned with lignin. Many other patents however, on the application of cellulose to other products are scattered throughout the many patent classifications. Copies of patents can be secured, of course, from the U. S. Patent Office for a nominal charge.

In summary, the literature on cellulose and related materials is scattered over many types of publications. Much of the information occurs in technical journals but even so there are many journals involved. The best way of searching for articles on cellulose and related materials is by the use of good abstracts such as *Chemical Abstracts* where the problem is greatly simplified by having such articles listed under Section 23, a relatively small section.

Miscellaneous Publications

Journal	*Nationality*	*Frequency of publication*	*Started*	*Duration*
Chemical Reviews	American	Bimonthly	1924	to date
Chemical and Engineering News	American	Weekly	1923	to date
Science	American	Weekly	1883	to date
Nature	British	Weekly	1869	to date

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Abstract Services Covering the Chemistry of Cellulose and Related Fields

CURTIS L. BROWN

THIS paper is the result of a survey of more than 200 publications containing condensed information on cellulose and related materials. For the purpose of a systematic dis-

CURTIS L. BROWN, Prevention of Deterioration Center, National Research Council, National Academy of Sciences, Washington, D. C.

cussion, these literature services can be divided into three general groups:

I. Journals devoted exclusively to one or more special fields in which cellulose plays a predominant role, notably the wood, paper, textile, plastics, and allied industries.
II. Periodicals covering practically all branches of chemistry and chemical technology, which regularly contain sections on cellulosic materials.
III. Publications dealing with science and technology in general, including chemistry, or with disciplines related to chemistry, in which information on cellulose appears more or less irregularly.

In all three of these groups, one can draw a somewhat arbitrary line between true abstract journals, i.e., journals devoted entirely or to a major extent to abstracts, and journals carrying abstracts as a secondary feature, either as a small regular section or at irregular intervals. Major abstract journals are usually well indexed, whereas minor abstract sections are generally indexed along with journal articles or not at all.

Annotated bibliographies, lists, indexes, reviews, and similar forms of publication were not primarily considered in this survey, although a few are included in the appendix. Another limitation of this discussion is that of language: This study was restricted mainly to abstracting services in English, French, and German—the three linguistic media cultivated most by scientists.

GROUP I

The most comprehensive domestic abstract service devoted to wood, paper, and allied industries is the *Bulletin of the Institute of Paper Chemistry, Library Notes.* This monthly bulletin, presently in its 24th volume, is published by The Institute of Paper Chemistry at Appleton, Wis. It is reproduced by the British Paper & Board Industry Research Association and, in microfilm form, by University Microfilms, Ann Arbor, Mich. *Library Notes* contain more than 4000 informative, concise, and up-to-date abstracts per year, covering the chemistry of cellulose and related substances such as lignin, and all phases and problems of pulp and paper technology. Book reviews and lists of current acquisitions of the Institute's library are included. Author, subject, and patent indexes are issued annually and decennially. The library also furnishes to Institute members reference lists and bibliographies on pertinent chemical and technological problems, as well as photostats and translations.

Examples of domestic journals carrying relatively short but good abstract sections are *Paper Industry, Paper Trade Journal,* and *Tappi.* The extensive annual compilation *Bibliography of Papermaking,* prepared by a Committee of the Technical Association of the Pulp and Paper Industry, formerly under the chairmanship of the late Dr. West, is undoubtedly familiar to all cellulose chemists.

Among foreign journals devoted entirely or partly to abstracts on wood and paper technology, two British publications—*Forestry Abstracts* (Commonwealth Forestry Bureau, Oxford) and *Technical Bulletin* (British Paper & Board Makers' Association)—deserve primary attention. Worth special mention are the *Condensed Translations,* from French, German, and Scandinavian sources, of the Canadian Pulp & Paper Association. Representative foreign journals carrying minor abstract sections are *Wood (London), La Papeterie, Cellulosa e Carta, Svensk Papperstidning,* and *Das Papier. Paper & Timber,* formerly *Finnish Paper & Timber Journal,* contains some English articles, English summaries of other articles, and a Finnish abstracts section.

In the fields of packaging, printing, and photography, information on cellulose, paper, and the like can be expected regularly in three American services—*Monthly Abstract Bulletin* (Kodak Research Laboratories), *Ansco Abstracts,* and *Lithographic Abstracts,* an annual compilation of the abstracts sections of four different journals. Similar British publications include the two Patra services, *Packaging Abstracts* and *Printing Abstracts,* as well as *Photographic Abstracts* (Royal Photographic Society).

At least two outstanding American abstract journals are devoted to textile chemistry, including of course cellulosic fibers and fabrics. The literature and patent service *Natural & Synthetic Fibers* is prepared monthly, with annual subject indexes, by Harris Research Laboratories, Washington, D.C., and Brooklyn Polytechnic Institute. This service is now in its 11th volume. The approximately 1000 yearly abstracts are well organized, up-to-date, and include some graphical material. Their loose-leaf form permits filing individual abstracts either by page number or by subject matter. Of eight subject categories, one deals exclusively with the production, properties, analysis, and applications of cellulosic fibers.

Another important contribution to textile literature is made by the extensive abstracts section of the *Textile Technology Digest,* published monthly, with semiannual indexes, by the Institute of Textile Technology, Charlottesville, Va. The ten well-organized parts of this abstract section deal with fiber properties and all steps of fiber and fabric production, finishing, testing, and performance.

Foremost among comparable British publications are *Proceedings & Abstracts, Journal of the Textile Institute,* Manchester, which have been issued separate from the *Transactions* of this journal since 1949. Now in their 45th volume, *Proceedings & Abstracts* contain some 3000 abstracts per year. They are issued monthly, with annual indexes, and cover all phases of fiber and fabric technology, including, of course, cellulosic textiles. Until the end of 1951, the abstracts also appeared as part of the *Textile Research Journal,* New York Textile Research Institute.

The literature of particular fibers is emphasized in *Empire Cotton Growing Review, Summary of Current Literature* of the British Cotton Industry Research Association, *Revue of Current Literature,* which was published between 1922 and 1929 by the Irish Linen Industry Research Association, and *Jute Abstracts* of the Indian Jute Mills Association Research Institute at Calcutta. Relatively small sections are devoted to abstracts, patent digests, and related review items, for instance, in *British Rayon & Silk Journal, Fibres (London),* and *Rayon & Synthetic Textiles.*

The textile field is further represented in several French journals such as *L'Industrie Textile, Coton et Fibres Tropicales (Bulletin Analytique),* and *Bulletin de l'Institut Textile de France,* which appears bimonthly in two parts—*Recherche* and *Documentation.* Some German monthlies carrying a number of pages of abstracts, book reviews, and patent descriptions are *Melliand Textilberichte, Textil-Praxis,* and *Zeitschrift für die Gesamte Textil Industrie.* Also worth mentioning are, among others, the Dutch abstract journal *AKU Documentation Bulletin* and the Indian *ATIRA Textile Abstracts.*

Covering the textile field from a special angle are the *American Dyestuff Reporter,* which contains a literature and patent digest feature in each issue since 1946, and the British *Journal of the Society of Dyers & Colourists,* now in its 70th volume, which devotes some 10 to 30 pages each month to abstracts. Of the 15 abstract sections, one deals with fibers, yarns, and fabrics, and one with paper and other cellulosic products. The German "Gegenstück" of these journals, *Deutsche Färber-Zeitung,* suffering the fate of many European publications, was apparently discontinued during the last war. The French "contre-partie," *TIBA,* was suspended between 1940 and 1948.

Cellulose and cellulose derivatives also play an important part in the modern plastics industry. Again, two American services are outstanding: The literature and patent service *Resins, Rubbers & Plastics* is the somewhat older counterpart of *Natural & Synthetic Fibers.* It is issued monthly in loose-

leaf form, with annual subject indexes, by Interscience Publishers. One subject division of this publication is devoted to the production, properties, and applications of all types of cellulosic resins and plastics.

Another comprehensive service in this field is *Abstract Reviews, National Paint, Varnish & Lacquer Association*, which appears in 11 issues per year, the twelfth being an annual index issue. Of the 17 sections of this periodical, one is devoted specifically to cellulose derivatives and related substances.

Two comparable British publications in the plastics field are *British Plastics Federation Abstracts*, containing some 3000 abstracts per year in monthly issues, and *Review of Current Literature* of the Research Association of British Paint, Colour & Varnish Manufacturers, which contains some 5000 abstracts per year in bimonthly issues.

Examples of abstract sections in domestic journals are those in *Modern Plastics*, *Organic Finishing*, and *Plastics Trends*. Some comparable foreign journals publishing abstract and/or patent review sections are *British Plastics*, *Revue Générale des Matières Plastiques*, *Kunststoffe*, *Deutsche Farben-Zeitschrift*, the East-Berlin publication *Chemische Technik*, which includes abstracts on *Kunststoff- & Kautschuk-Technik*, and *Plastica* of the Dutch Plastics Research Institute at Delft.

Before proceeding to the second group of abstract services, it must be pointed out that the number of both domestic and foreign journals in special fields, including those related to cellulose chemistry, increases steadily and that almost every one of them provides some sort of timely literature survey, review, digest, or similar feature for its readers. The appended bibliography includes some of these but makes no claim at completeness.

GROUP II

In the group of general abstract journals covering all branches of pure and applied chemistry, *Chemical Abstracts* is of greatest importance. Now in its 48th year, it covers well over 5000 journals, publishes in excess of 50,000 abstracts per year, and, with its extensive annual and decennial author, subject, patent, and formula indexes, is certainly one of the best, if not the best, of chemical abstract services. Of particular interest to the cellulose chemist are five sections—*Cellulose & Paper*, formerly edited by Dr. West, *Dyes & Textile Chemistry*, *Synthetic Resins & Plastics*, *Paints, Varishes & Lacquers*, and *Photography*. The cross references in the individual sections and the thorough indexing job of *Chemical Abstracts* make it unlikely that any item of interest to the cellulose field is missed. As a matter of fact, most special abstracting services, which are of necessity limited in their journal coverage, consult *Chemical Abstracts* as a fairly good check on the completeness of their own coverage, particularly as far as foreign and other less accessible sources of information are concerned.

British Abstracts, according to one source, published 11,000, according to another, 30,000 abstracts annually, covering some 1600 journals. Author, subject, and formula indexes are issued annually and pentennially. The applied chemistry part of this journal contains regular sections on wood, paper, textiles, plastics, and allied materials.

In this group of English-language publications, there should be included *Australian Chemical Abstracts*, which were discontinued at the end of 1950; the somewhat specialized abstracts in *Spectrochimica Acta* and in *Vacuum; Hungarian Technical Abstracts* (*Magyar Müszaki Lapszemle*), a quarterly published since 1949 in English, German, and Russian editions; and *Japanese Chemical Abstracts* (*Nippon Kagaku Soran*), now in its 28th volume, which appears approximately once a month and contains some English translations or excerpts.

Most countries, in which chemical research is pursued on a level comparable to ours, are not so fortunate to have a centralized chemical abstract service. To obtain a fairly complete picture of pertinent developments in France, e.g., one would have to consult at least three sources: the extensive *Documentation* sections of *Bulletin de la Société Chimique de France* (for pure chemistry abstracts) and of *Chimie et Industrie* (for applied chemistry abstracts), as well as the *Bulletin Analytique* (for general chemical and related science abstracts). A similar situation exists in Italy, where chemical abstracts are published in several journals, notably *La Gazzetta Chimica Italiana* and *La Chimica e l'Industria* (Milan); in Belgium, where *Bulletin de la Société Chimique Belges* and *L'Industrie Chimique Belge* are reliable sources of pure and applied chemistry abstracts, respectively; and in practically all Latin-American countries.

Germany is more fortunate in this respect. *Chemisches Zentralblatt*, now in its 125th volume and published weekly, contains at least 10,000 abstracts annually and is probably the best continental abstract service of its kind. Its applied chemistry part contains regular sections on wood, paper, textiles, plastics, and related materials. Author, subject, patent, and formula indexes are issued annually and pentennially. (A separate "Register" of trivial names is also contemplated.)

Worth mentioning, but probably of limited use to American chemists, are various general chemical abstract journals published in less universally used languages. Thus, the *Review of Technical & Economics Literature* (*Přehled Technické a Hospodarské Literatury*) issued in Prague and now in its 11th volume publishes some 3000 to 4000 abstracts annually, including abstracts on the technology of wood, paper, textiles, plastics, and related industries. Characteristic of probably all publications behind the Iron Curtain, the first sections of this Czech publication are devoted to national and international politics, economy, and particularly to the Marx-Lenin doctrine. *Referativnyi Zhurnal, Khimiya* (*Russian Chemical Abstracts*) was started only last year (October, 1953) as one of four abstract journals published by the new Soviet Institute of Scientific Information.* If continued semimonthly, it will contain some 50,000 abstracts annually covering Russian and foreign journals, patents, books, newspaper articles, and dissertations. For most chemists, who do not understand Russian, condensed information from Soviet sources is, however, practically limited to the material covered in *Chemical Abstracts* and similar European abstract journals and in some sporadic bibliographic lists of titles with occasional annotations, such as *Guide to Russian Scientific Periodical Literature* coming from Brookhaven National Laboratory, *Monthly List of Russian Accessions* compiled by the Library of Congress, and *Translated Contents Lists of Russian Periodicals* of the British Department of Scientific & Industrial Research.

GROUP III

The last group of abstract journals comprises those which cover a broad or narrow field of science related to or embracing certain branches of chemistry. In this group can be included *European Scientific Notes*, *FIAT Revue of German Science*, which serves to bridge a lack of wartime information, the annotated *List of Documents Received from British Commonwealth Sources*, and *Dissertation Abstracts*, formerly *Microfilm Abstracts*, issued at Ann Arbor, Mich., and containing annually some 200 author-written abstracts of dissertations and monographs available on microfilm.

Biological Abstracts, in which a few subsections deal with forestry and with cellulose-destroying organisms, is definitely of interest to the cellulose chemist. Certain aspects of packaging and sanitation in primarily medical, food science, and related fields may also throw some light on the chemistry of cellulose and similar materials. This may justify the mention

* *Chemical & Engineering News* 32, No. 8: 764 (Feb. 22, 1954).

of abstract services like *Squibb Abstract Bulletin, Current Abstracts of Scientific & Technical Literature* (General Foods Corp.), the British *Food Science Abstracts*, and the abstract sections in periodicals such as *Stain Technology* and *Pest Control.*

Equally if not more important are a large number of services covering general or specific technical and engineering fields, such as the building, railroad, and telecommunications industries, in which wood and wood products are used extensively, and the electrical industries, in which cellulosic insulating materials and the like are important. Among these abstracting services one can enumerate the following domestic publications: *Engineering Index, Engineer's Digest, Technical Survey, NACA Research Abstracts, Nuclear Science Abstracts, Highway Research Abstracts* (National Research Council), *Battelle Technical Review, Science & Technology* (Carnegie Library), *Naval Research Laboratory Library Bulletin*, and the two recently reorganized services *Technical Information Pilot* and *Technical Data Digest.* Also in this group belong various sections in *Materials & Methods*, as well as the partly annotated *OTS Bibliography of Technical Reports.*

Among similar British publications must be mentioned the two parts of *Science Abstracts—Physics Abstracts* and *Electrical Engineering Abstracts—Weekly Abstracts* of the Electrical Research Association, *Building Science Abstracts*, and *Railway Engineering Abstracts.* Comparable French journals are *Documentation Technique, Bulletin de Documentation Technique* (SNCF), and *Revue Générale de l'Electricité.* Other foreign technical publications include *KLM Literatuuroverzicht* (Royal Dutch Airlines), the Italian *Documentazione de Ingeneria,* the Roumanian Government publication *Buletinut de Documentare Tehnica,* the Swedish *Building Literature* (*Bygglitteratur*),the Japanese *Abstracts of the Latest Engineering Literature* (*Saichin Kogaku Bunken Tekiroku Tsushin*), and the abstracts and patent digest features of the *Journal of Scientific & Industrial Research* (India).

Special attention in the large group of general technical abstract publications must be given to the *Official Gazette* of the U. S. Patent Office and to similar publications of foreign countries. In the year 1952 alone, the U. S. *Gazette* published claims of nearly 44,000 patents granted. According to an earlier survey,† of the $2^1/_2$ million U. S. patents granted up to 1950, approximately 200,000 are of a chemical nature. As a rough estimate, 5 to 10% of these chemical patents, i.e., some 10,000 to 20,000 annually are more or less related to timber, paper, textiles, and allied cellulose-containing products. The "Manual of Classification of Patents," supplemented by *Classification Bulletins*, is an indispensable aid in locating, among the 45,000 or so subject classes and subclasses of our patent system, those pertaining to cellulose chemistry.

Among foreign publications corresponding to the *Official Gazette*, the *Official Journal of Patents* of the British Patent Office deserves particular mention, because it contains abstracts, i.e., illustrated abridgements of patents, and not just reproductions of patent claims. Some other patent journals published in abstract form are those of Argentina, Australia, Belgium, Canada, and Norway. Most of the comparable patent journals of other countries, including the German *Patentblatt* and the French *Bulletin Official de la Propriété Industriale*, are essentially lists rather than abstracts or excerpts. Explanations of foreign patent classification systems are available at the U. S. Patent Office and also in Severance's "Manual of Foreign Patents."‡ Also worth mentioning for its value to cellulose chemistry is the compilation of patents in Faust's two-volume work "Cellulose-verbindungen."§

Last in this discussion of abstract services, though by no means the least important, is one which contains ample information pertaining to cellulose chemistry and related subjects, but which is difficult to classify into any of the foregoing groups, because it is probably unique in its particular slant and because it cuts across several scientific disciplines. This service, with which the author is most familiar, is *Prevention of Deterioration Abstracts*, a publication of the Prevention of Deterioration Center of the National Research Council—National Academy of Sciences. It is a continuation of the *Tropical Deterioration Bulletin*, which started its function under the Office of Scientific Research & Development during the last war, when the exorbitant amount of deterioration of military supplies and equipment became a pressing problem. The Prevention of Deterioration Center, PDC for short, and its abstract service are sponsored jointly by Air Force, Army, and Navy. The abstracts cover every form and aspect of natural deterioration of all types of strategic materials and equipment, and the most important developments in the prevention of such deterioration. This abstract publication, which appears monthly in loose-leaf form, is divided into 14 sections, of which seven are of interest to the cellulose field. These are the sections entitled Wood & Paper Products; Textiles & Cordage; Plastics, Resins, Rubber & Waxes; Packaging & Storage; Optical Instruments & Photographic Equipment; Biological Agents; and Fungicides & Other Toxic Compounds. Approximately 1000 abstracts plus cross references and author and subject indexes are issued annually in two binders. The abstracts are informative, as complete as is possible without graphical aids, and more than one page long on the average. They also frequently contain critical or correlating comments by the technical staff of the Center. Articles appearing in little accessible sources, such as unpublished and foreign-language reports, are covered in detail. More than one fourth of the abstracts originate abroad, approximately one fourth are taken from the domestic and foreign patent literature, and almost one fourth cover unpublished research results in this special field.

In addition to this abstract service, PDC maintains a special library, which is probably unique in the world for its collection of some 20,000 reports in the field of deterioration prevention. The library issues a monthly list of accessions, called *Advance List*, which gives titles and related bibliographic information of up to 250 reports received during each month. Duplicate copies of reports are available on a loan basis to all authorized institutions—governmental, industrial, and academic—as well as to private individuals. Where only single copies are on file, they must be consulted at the Center.

CONCLUSION

In conclusion, a short contemplation of the multitude of existing abstract services, even in such a restricted field as cellulose chemistry, is in order. About the only thing common to all of them is variety. Services range from occasional short annotations in the back of a journal to all-out abstract publications comprising several thousand abstracts annually published at consistent intervals. The abstracts themselves vary in length, quality, type, and scope.

Not too long ago, at a Baltimore symposium,‖ the remark was made that scientists are about to bury themselves under the weight of their own printed matter. It was also said that the function of abstracting and indexing services in the maze of scientific literature is comparable to that of road maps and telephone directories in the geographical, political, and business world. Extending this simile, a special abstracting service can be compared with the floor plan or office directory of a building or factory. The more buildings are added to

† J. Fleischer, in "Searching the Chemical Literature," Advances in Chemistry Series No. 4, American Chemical Society (1951), p. 61.

‡ Patent Office Society of Washington, D. C., 1935.

§ Edward Bros., Inc., Ann Arbor, Mich., for Alien Property Custodian, 1944.

‖ "Symposium on Machine Techniques in Scientific Documentation, Johns Hopkins University, Baltimore, Md., March 3, 1953.

the architecture of a town, the more special directories are needed. Similarly, the greater the number of buildings, annexes, and branch offices in our scientific landscape, the more and better special and general publications are needed to facilitate speedy and efficient orientation, traffic, and transfer of scientific information.

APPENDIX: ABSTRACTING SERVICES OF INTEREST TO THE CELLULOSE CHEMIST—A SELECTIVE, ANNOTATED BIBLIOGRAPHY

I. Special Publications

A. Wood, Paper, and Allied Industries

DOMESTIC SERVICES

1. Ansco Abstracts — Ansco, Binghamton, N. Y. Monthly. (Internal circulation only.) 800 abstracts per year, 75 journals. Annual author and subject indexes.
2. Bibliography of Papermaking & U. S. Patents — Technical Assn. of the Pulp and Paper Industry, New York, N. Y. Annual compilation with author & subject indexes, 3000 abstracts and titles per year.
3. Bulletin of the Institute of Paper Chemistry, Library Notes — Institute of Paper Chemistry, Appleton, Wis. (Reproduced by British Paper & Board Industry Research Assn., Kenley, Surrey. Also, on microfilm, by University Microfilms, Inc., Ann Arbor, Mich.) Monthly. 4000 abstracts per year, 300 journals. Annual and decennial author, subject and patent indexes. Vol. 39 (Sept., 1953).
4. Journal of Forestry — Society of American Foresters, Washington, D. C. Monthly. Vol. 52 (1954). "Current Literature" section.
5. Journal of the Forest Products Research Society — Forest Products Research Soc., Madison, Wis. 5× per year. Vol. 3 (1953). "New Publications" section. "Abstracts" section taken from other services, e.g., 3, 20, 50.
6. List of Publications, Forest Products Laboratory — Forest Service, U. S. Dept. of Agriculture, Madison, Wis. 200 abstracts and annotations per year.
7. Lithographic Abstracts — Lithographic Technical Foundation, Inc., Chicago, Ill. Annual compilation of abstract sections in four journals: *Natl. Lithographer*, *Lithographer's Journal*, *Modern Lithography*, and *British & Colonial Printer*. 275 abstracts per year, 100 journals. No index.
8. Monthly Abstract Bulletin — Kodak Research Labs., Eastman-Kodak Co., Rochester, N. Y. 2200 abstracts per year, 375 journals. Annual author index. Vol. 39 (1953).
9. The Paper Industry (& Paper World) — Fritz Publications, Inc., Mount Morris, Ill. Monthly. Vol. 35 (1953). "Foreign Abstracts," "New Literature," etc., sections.
10. Paper Trade Journal — Lockwood Trade Journal Co., New York, N. Y. Weekly. 400 abstracts per year. Vols. 136/137 (1953). Various literature and patent review sections.
11. Tappi — Technical Assn. of the Pulp and Paper Industry, New York, N. Y. Monthly. Vol. 37 (1954). 600 abstracts per year appearing quarterly in "U. S. Patents on Papermaking" section.

FOREIGN SERVICES

12. Allgemeine Papier-Rundschau (Zellstoff & Papier; Neue Deutsche Papier-Zeitung) — Frankfurt am Main. Monthly. Vol. 1952. Patents and other review items.
13. A.T.I.P. Abstracts — Association Technique de l'Industrie Papetière, Paris. Abstract Service on Punched Cards. (No information.)
14. Bois et Forêts des Tropiques — Centre Technique Forestier Tropical, Nogent-sur-Marne, Seine, France. Started 1947. Bimonthly since 1952. No. 33 (Jan./Feb., 1954). Abstract section "Documentation Analytique," as well as English and Spanish summaries of original articles.
15. Bulletin of the Government Forest Experiment Station — Forest Experiment Station, Tokyo. Irregularly. No. 66/67 (Jan., 1954). English articles and English summaries of Japanese articles.
16. Cellulosa e Carta (Cellulose & Paper) — Ente Nazionale per la Cellulosa e per la Carta, Italy. Monthly. Vol. 4 (1953). Italian abstract section and patent bibliography.
17. Condensed Translations — Canadian Pulp & Paper Assn., Montreal. 6× per year. 100-200 condensations per year from French, German, and Scandinavian journals. Vol. 16 (1954).
18. To Dasos (The Forest) — Ministry of Agriculture, Forest Service Propaganda Section, Athens, Greece. Quarterly. Started 1947. Vol. B No. 5 (Jan., 1948). Greek abstract section.
19. Empire Forestry Review (The Empire Forestry Journal) — Empire Forestry Assn., London. Quarterly. Vol. 32 (1953). "Extracts from Forestry Abstracts" section.
20. Forest Products Utilization Abstracts — Commonwealth Agricultural Bureau, London. Quarterly. 1200 abstracts and titles per year from 30 languages. Separate reprint of Sections 3, 7, and 8 of Forestry Abstracts.
21. Forestry Abstracts — Commonwealth Forestry Bureau, Oxford. Quarterly. Started 1946. 1300 abstracts per year. Vol 14 (1953).
22. La Forêt — Société Forestière Suisse & Assn. Suisse d'Economie Forestière, Neuchâtel. Monthly. Vol. 7 (1954). Minor literature and book review section.
23. Der Forst- und Holzwirt (Forst und Holz) — Verlag M. & H. Schaper, Hannover. Monthly. Vol. 9 (1954). Abstract section "Zeitschriften Archiv" and book reviews.
24. Forstarchiv — Verlag M. & H. Schaper, Hannover. Quarterly. Vol. 25 (1954). Extensive abstract section "Forstliches Schrifttum" and book review section.
25. Forstliche Rundschau — Verlag J. Neumann, Neudamm & Berlin. Two double numbers per year. Vol. 16 (1944). All-out abstract journal.
26. Holz als Roh- und Werkstoff — Springer-Verlag, Berlin and London. Monthly. Vol. 11 (1953). Various literature sections.
27. Holzforschung — Verlag Herbert Cram, Berlin. Irregularly. Vol. 7 (1953). Minor abstract section.
28. Holztechnik (Holzindustrie & other journals combined) — Holztechnik-Verlag, Mainz. Monthly. Vol. 33 (1953). Patent and book review sections.
29. Internationaler Holzmarkt — Vienna, Austria. Biweekly. Vol. 1953. "Holzdokumentation" section (similar to West's Bibliography of Papermaking).

30. Journal Forestier ,Suisse (Schweizerische Zeitschrift für Forstwesen)	Société Forestière Suisse, Zurich. Bimonthly double numbers. Vol. 104 (1953). Abstract section "Revue des Revues" and book reviews.
31. The Journal of the Japanese Forestry Society	Japanese Forestry Soc., Tokyo. Monthly. Vol. 36 (1954). Abstracts and book reviews in Japanese. English summaries of original articles.
32. Il Legno	Sindacato dei Commercianti del Legno, Milan. Biweekly. Vol. 33 (1954). Patent digest and book review sections.
33. Mitteilungen der Forstlichen Bundes-Versuchsanstalt Mariabrunn	Österreichische Staatsdruckerei, Vienna. Annually (?). Vol. 48 (1952). Abstracts ("Referate") and book review sections.
34. Österreichische Vierteljahresschrift für Forstwesen	Österreichischer Forstverein, Vienna. Quarterly. Vol. 1953. Abstracts ("Forstliche Bibliographie") and book review sections.
35. Packaging Abstracts	Patra (Printing, Packaging & Allied Trades Research Assn.) Leatherhead, Surrey. Monthly. 5000 abstracts per year, 200 journals. Annual index. Vol. 11 (1954).
36. Pakistan Journal of Forestry	Abbottabad, Pakistan. Quarterly. Vol. 3 (1953). Abstract and review sections.
37. Paper & Timber (Paperi ja Puu; Papper och Trä; formerly Finnish Paper & Timber Journal)	Central Assn. of Finnish Woodworking Industries, Helsinki. Monthly. Vol. 35 (1953). Abstracts in Finnish, articles in English or with English summaries.
38. La Papeterie	L'Homme et Argy, Ltd., Paris. Monthly. Vol. 76 (1954). Literature and patent abstracts sections.
39. Das Papier	Eduard Röthen Verlag, Darmstadt. Monthly double numbers. Vol. 7 (1953). Minor abstract, patent survey and book review sections.
40. Der Papier-Fabrikant	Otto Elsner Verlag, Berlin. Monthly. Merged into Wochenblatt für Papierfabrikation with Vol. 41 (1943). Literature and patent abstract sections, book reviews.
41. Photographic Abstracts	Royal Photographic Society, London. Quarterly. 1300 abstracts per year, 100 journals. Annual author and patent indexes. Decennial subject indexes. Vol. 31 (1951).
42. Printing Abstracts	Patra, Leatherhead, Surrey. Monthly. 2000 abstracts per year, 200 journals. Annual author and subject indexes. Vol. 8 (1953).
43. Przeglad Bibliograficzny Leśnictwa (Polish Forest Review)	Instytut Badaczego Les'nictwa, Warsaw. Monthly. Vol. 1 (1950). All-out abstract journal in Polish.
44. Przeglad Bibliograficzny Papiernictwa (Polish Paper Review)	Eksposytura Czasopism Technicznych, L'odz. Monthly. Vol. 2 (1951). Separate supplement to Przeglad Papierniczy (Paper Bulletin).
45. Pulp & Paper Magazine of Canada	Canadian Pulp & Paper Assn., Gardenvale, Quebec. Monthly. Vol. 54 (1953). Condensed meeting papers and related sections.
46. Revue Forestière Française	Ecole Nationale des Eaux et Forèts, Nancy. Monthly. Vol. 1953. Abstracts ("Revue des Revues") and book review sections.
47. Šumarstvo (Forestry)	Foresters' Society of Serbia, Belgrad. Monthly (?). Vol. (or No.) 6 (1953). Serbian abstract section ("Forest Technical Press").
48. Svensk Papperstidning (Swedish Paper Journal)	Stockholm. Semimonthly. Vol. 56 (1953). Abstracts ("Fackliteraturen"), patent digest and book review sections.
49. Technical Bulletin	Technical Section, British Paper & Board Makers' Assn., Inc., Kenley, Surrey. 6× per year. Vol. 31 (1954). Extensive section of condensed translations from French, German, Italian, Scandinavian, Polish, and other sources. No index.
50. Technical Bulletin of the Furniture Development Council	London. Bimonthly. Several hundred abstracts and reviews per year.
51. Timber & Woodworking Abstracts	Timber News Ltd., London. Monthly. Vol. 62 (1954). Abstracts section and book reviews *in* Timber Technology.
52. Wochenblatt für Papierfabrikation	Güntter-Staib Verlag, Biberach an der Riss, Württemberg. Weekly. Suspended between 1944–47. Vol. 82 (1954). Abstract section, patent list, and book reviews.
53. Wood (Chicago)	American Lumberman, Inc., Chicago. Monthly. Vol. 6 (1951). Abstract section, patent digest and other review items.
54. Wood (London)	Tothill Press, Ltd., London. Monthly. Vol. 18 (1953). Patent and book review sections.
55. The World's Paper Trade Review	Stonhill & Gillis, Ltd., London. Weekly. Vols. 135/136 (1951). Patent review section "Paper-Making Developments."
56. Zeitschrift für Weltforstwirtschaft (Journal of World Forestry)	Krögers Verlagsanstalt G.m.b.H., Hamburg-Blankensee. Quarterly. Vol. 16 (1953). Two abstract sections. "International Forest Review" & "International Review of Wood Technology & Forest Utilization." Also book reviews.
B. Textile and Allied Industries	
Domestic Services	
57. American Dyestuff Reporter	Howes Publishing Co., Inc., New York, N. Y. Biweekly. 800 abstracts per year in "Abstracts" and "Patent Digest" sections since 1946. Vol. 43 (1954).
58. Natural & Synthetic Fibers	Interscience Publishers, New York, N. Y., in collaboration with Harris Research Labs., Washington, D. C., and Brooklyn Polytechnic Institute. Monthly in loose-leaf form. 1000 abstracts per year, 100 journals. Annual subject index. Also monthly "Highlights" of recent developments. Vol. 11 (1954).
59. Textile Technology Digest	Institute of Textile Technology, Charlottesville, Va. Monthly. 3000 abstracts per year. Semiannual author and subject indexes. Vol. 10 (1953).
60. Textracts	J. B. Goldberg, New York, N. Y. Monthly. Started July, 1953. Summary of domestic and foreign textile news and technology.
Foreign Services	
61. AKU Documentation Bulletin	Algemeene Kunstzijde Unie, Holland. Semiannually. English abstracts section. Dutch articles.
62. ATIRA Textile Abstracts	Ahmedabad Textile Industries Research Assn., India. Bimonthly double numbers. Vol. 3 (1952).
63. Die Bastfaser	Verlag F. L. Wagener, Berlin. Monthly. Discontinued with Vol. 4 (1944). Extensive literature and patent abstract sections.
64. Bollettino della Cotoniera	Federazione Nazionale degli Industriali Cotonieri, Milan. Monthly. Discontinued with Vol. 38 (1943). Abstracts section ("Bibliografia") and other review items.

65. British Rayon & Silk Journal (Silk Journal & Rayon World)	Harlequin Press Co., Ltd., Manchester. Monthly. Vol. 31 (1954). "Technical Abstracts," "Recent Patents," "Book Reviews," and "Trade Publications" sections.
66. Bulletin de l'Institut Textile de France	Editions de l'Industrie Textile, Paris. Bimonthly. Vol. 23 (1951). In two parts: "Recherche" and "Documentation" (Abstracts).
67. Canadian Textile Journal	Canadian Textile Journal Publishing Co., Ltd., Montreal and Quebec. Biweekly. Vol. 69 (1952). "Technical Literature" section.
68. Coton et Fibres Tropicales, Bulletin Analytique	Institut de Recherches du Coton et des Textiles Exotiques, Paris. Quarterly. Vol. 7 (1952). Separate supplement to Coton et Fibres Tropicales (semiannual).
69. Deutsche Färber-Zeitung	Liegnitz. Suspended with Vol. 78 (1942). Minor abstract section.
70. Empire Cotton Growing Review	Empire Cotton Growing Corp., London. Quarterly. Vol. 28 (1951). All-out abstract journal.
71. Faserforschung	Fr. Tobler, Dresden. Irregularly. Suspended with Vol. 16 (1942–44). Literature and book review sections.
72. Fibres (London) (Textile Industries & Fibres)	Leonard Hill, Ltd., London. Monthly. Vol. 14 (1953). "Fibres Digest," "Patent Abstracts," and condensed meeting papers sections.
73. Fibres, Fabrics & Cordage (Irish & International Fibres & Fabrics; Fibres & Fabrics Journal)	H. R. Carter Publications, Ltd., Belfast, Northern Ireland. Monthly. Discontinued with Vol. 17 (1950). "Textile Patents" abstract section.
74. The Indian Cotton Growing Review	Indian Central Cotton Committee, Bombay. Monthly (?). Vol. 7 (1953). "Summary of Current Literature" section.
75. L'Industrie Textile	Editions de l'Industrie Textile, Paris. Monthly. Vol. 70 (1953). Abstract and patent digest sections.
76. Journal of the Society of Dyers & Colourists	Society of Dyers & Colourists, Bradford, Yorkshire. Monthly. 3000 abstracts per year in extensive "Abstracts" section. Annual indexes. Vol. 70 (1954).
77. Journal of the Textile Institute, Proceedings & Abstracts	Textile Institute, Manchester. (Reproduced by Textile Research Institute, New York, until end of 1951 *in* Textile Research Journal.) Monthly. 4000 abstracts per year, 175 journals. Annual indexes. Vol. 44 (1953).
78. Jute Abstracts	Indian Jute Mills Assn. Research Institute, Calcutta. Quarterly. Vol. 12 (1948).
79. Melliand Textilberichte	Heidelberg. Monthly. Vol. 34 (1953). Abstracts, patent survey, and book review sections.
80. Rayonne et Fibres Synthétiques	Comité International de la Rayonne et des Fibres Synthétiques, Brussels. Monthly. Vol. 10 (1954). Abstract section ("Revue des Revues").
81. Review of Current Literature	Irish Linen Industry Research Assn., Lambeg, Lisburn, Northern Ireland. Published between 1922–29.
82. Reyon, Zellwolle und andere Chemiefasern (Kunstseide und Zellwolle)	H. Jentgen Verlag K. G., Berlin-Lichterfelde. Monthly. Vol. 31 (1953). Abstracts ("Forschungen und Fortschritte") and "Neue Patente" sections, etc.
83. Skinner's Silk & Rayon Record (Silk & Rayon)	Manchester. Monthly. Vol. 26 (1954). "Technical Literature" and patents section.
84. Summary of Current Literature	British Cotton Industry Research Assn., Manchester. Semimonthly. 4500 abstracts per year, 200 journals. Vol. 33 (1953).
85. Textil-Praxis	Konradin Verlag, Stuttgart. Monthly. Vol. 6 (1951). Abstract and patent review sections.
86. Textil-Rundschau	Verlag Zollikofer & Co., St. Gallen, Switzerland. Monthly. Vol. 9 (1954). Abstracts ("Kurzreferate") section.
87. The Textile Journal of Australia	Wilke & Co., Melbourne. Monthly. Vol. 28 (1953). Australian patent review and other review items.
88. TIBA (Revue Générale de Teinture, Impression, Blanchiment, Apprêt . . .)	Jean-Jaurès, Paris. 10× per year. Suspended between May, 1940–July, 1948. Vol. 28 (1951).
89. Zeitschrift für die Gesamte Textilindustrie (Klepzig's Textilzeitschrift & other textile journals combined)	Gemeinschaftsverlag H. Klapp & L. A. Klepzig, München-Gladbach. Semimonthly. Vol. 55 (1953). Literature and patent surveys.

C. Resins, Plastics, and Allied Industries

Domestic Services

90. Abstract Reviews	Natl. Paint, Varnish & Lacquer Assn., Washington, D. C. Monthly. 1500 abstracts per year. Annual author and subject indexes. No. 197 (Jan., 1954).
91. Modern Plastics (Plastic Products)	Modern Plastics, Inc., New York, N. Y. Monthly. 700 abstracts per year, 30 journals. Annual subject index. Vol. 31 (1954). "Plastics Digest" section and annual literature review in each January issue.
92. Organic Finishing	Finishing Publications, Inc., Westwood, N. J. Monthly. Vol. 15 (1954). Patent reviews and manufacturers' literature sections.
93. Paint & Varnish Production (Paint & Varnish Record)	Powell Magazines, Inc., New York, N. Y. Vol. 44 (1954). Abstract and patent survey sections.
94. Plastics Trends	Plastics Industries Technical Institute, West Coast University, Los Angeles, Calif. 400 abstracts per year, 30 journals. Monthly indexes. Vol. 14 (1954). Abstract section.
95. Resins, Rubbers & Plastics	Interscience Publishers, Inc., New York, N. Y. Monthly in loose-leaf form. 1000 abstracts per year. Annual subject index. Vol. 14 (1954).

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96. British Gelatine & Glue Research Assn. Abstracts	London. (No information.)
97. British Plastics	Iliffe & Sons, London. Monthly. Vol. 26 (1953). "Technical Literature" section.
98. British Plastics Federation Abstracts	British Plastics Federation, London. Monthly. 3000 abstracts per year, 80 journals. Annual author and subject indexes.
99. Chemische Technik (incl. Kunststoff- und Kautschuk-Technik)	Kammer der Technik, East-Berlin. Vol. 5 (1953). Abstract section.
100. Deutsche Farben-Zeitschrift	Wissenschaftliche Verlagsgesellschaft m.b.H., Stuttgart. Vol. 7 (1953). Abstract section.
101. Farbe und Lack	Verlag Curt R. Vincentz, Hannover. Monthly. Vol. 59 (1953). Abstracts, patent lists, book reviews, industrial literature, etc.
102. Fette und Seifen, einschl. der Anstrichmittel	Industrieverlag von Hernhaussen K. G., Hamburg, Berlin & Münster. Vol. 55 (1953). Abstracts section.

103. Kunststoffe	Carl Hauser Zeitschriftenverlag G.m.b.H., Munich. Vol. 43 (1953). Literature and patent review sections.
104. Paint Manufacture	Leonard Hill, Ltd., London. Vol. 24 (1954). "Recent Technical Abstracts," "New British Patents" and related sections.
105. Peintures, Pigments, Vernis	Société de Productions Documentaires, Paris. Vol. 30 (1953). "Documentation" section.
106. Plastica	Plastics Research Institute, Delft, Holland. Monthly. 500 abstracts per year, 30 journals. No index. Vol. 4 (1951). Abstract section.
107. Plastics (London)	Temple Press, Ltd., London. Monthly. Vol. 18 (1953). Abstract section "Patent Review."
108. Review of Current Literature on Paint, Colour, Varnish & Allied Industries	Research Assn. of British Paint, Colour & Varnish Manufacturers, London. Bimonthly. 5000 abstracts per year, 140 journals. Annual author and subject indexes. Vol. 26 (1953).
109. Revue Générale des Matières Plastiques	Paris. 10× per year. Vol. 27 (1951). Suspended between 1940–47. Abstracts and patent digest sections.
110. Travaux de Peinture	Union Nationale des Peintres Vitriers de France, Paris. Monthly. Vol. 8 (1953). "Documentation" section.

II. General Chemical Publications

English-Language Services

111. Australian Chemical Abstracts	Supplement to Journal & Proceedings of the (Royal) Australian Chemical Institute. Discontinued with Vol. 12 (Nov., 1950).
112. British Abstracts (British Chemical & Physiological Abstracts)	Bureau of Abstracts, London. Monthly. 11,000 (30,000 according to a different source) abstracts per year, 1600 journals. Annual and pentennial author, subject, patent, and formula indexes. Discontinued with Vol. 1953.
113. Chemical Abstracts	American Chemical Society, Easton, Pa. Semimonthly. Over 50,000 abstracts per year, 5000 journals. Annual and decennial author, subject, patent, and formula indexes. Vol. 48 (1954).
114. Hungarian Technical Abstracts (Magyar Müszaki Lapszemle)	Budapest. Quarterly. English, German, and Russian editions. Vol. 5 (1953).
115. Japanese Chemical Abstracts (Nippon Kagaku Soran)	Japanese Chemical Research Society, Sendai. Approx. monthly. English translations and excerpts. Vol. 26 (1952).
116. Journal of Applied Chemistry (Journal of the Society of Chemical Industry) (London)	Society of Chemical Industry, London. Monthly. Started in 1951. Extensive abstracts section since Vol. 4 (Jan., 1954).
117. Journal of the Chemical Society (London)	London. Abstracts between 1871–1925, with cumulative indexes.
118. Polish Technical Abstracts (Obzor Pol'sko Tekhnicheskoĭ Literatury)	Glowny Instytut Dokumentacji Naukowo-Teckhnicznej, Warsaw. Quarterly. English and Russian editions. Vol. 1951.
119. Spectrochemical Abstracts	Butterworth-Springer, Ltd., London. 2–3× per year. Section of Spectrochimica Acta. Annual author and subject indexes. Vol. 4 (1951).
120. Vacuum Classified Abstracts	W. Edwards & Co., Ltd., London. 4× per year. Section of Vacuum. Vol. 2 (1952).

Foreign-Language Services

121. Angewandte Chemie (Zeitschrift für angewandte Chemie)	Verlag Chemie G.m.b.H., Weinheim. Semimonthly. Abstract ("Rundschau") and book review sections. Annual and 20-year author, subject, and patent, indexes. Vol. 63 (1951).
122. Boletín de la Sociedad Chilena de Quimica	Concepción, Chile. Irregularly. Vol. 5 (1953). Abstracts of foreign news and of Chilean journal articles. Book reviews and lists of doctoral theses, etc.
123. Bulletin Analytique	Centre de Documentation du Centre National de la Recherche Scientifique, Paris. 50,000–100,000 abstracts per year, 4000 journals. Three parts: Physical Sciences, Biological Sciences (both monthly), and Philosophy (3× per year).
124. Bulletin de la Société Chimique Belges	Vlaamsche Chemische Vereeniging, Brussels. 12 numbers per year. Vol. 62 (1953). Abstract section.
125. Bulletin de la Société Chimique de France	Masson & Co., Paris. Monthly. Documentation section ("Travaux") publ. separate from "Memoirs" in even-numbered volumes between 1892–1949. Annual and approx. decennial author and subject indexes.
126. Chemiker-Zeitung (mit Chemie-Börse)	Alfred Hüthig Verlag, Heidelberg. 3 numbers per month. Vol. 77 (1953). Abstracts section.
127. Chemisches Zentralblatt	Akademie-Verlag, Berlin. Weekly. 10,000 abstracts per year, 2000 journals. Annual and pentennial author, subject, patent, and formula indexes. Vol. 124 (1953).
128. La Chimica e l'Industria (Giornale di Chimica Industriale ed Applicata)	Associazione Italiana di Chimica, Milan. Monthly. Vol. 35 (1953). Abstracts section.
129. Chimie et Industrie	Société de Chimie Industrielle, Paris. Monthly. 1000 abstracts per year in "Documentation" section. Annual author, subject, patent, and book indexes. Vols. 67/68 (1952).
130. Fresenius' Zeitschrift für analytische Chemie	Springer-Verlag, Berlin, Göttingen & Munich. Irregular. Vol. 137 (1952/53). Large abstract section.
131. Gazzetta Chimica Italiana	Rome. Monthly. Vol. 83 (1953). Abstract section (separate between 1881–87).
132. Industria y Qu´mica (Buenos Aires)	Asociación Química Argentina, Buenos Aires. 10× per year (monthly fr. March–Dec.). Vol. 15 (1953). Patent abstracts section, book reviews, etc.
133. L'Industrie Chimique (et Le Phosphate)	Paris. Monthly. Suspended between 1942–45. Vol. 41 (1954). Abstracts section.
134. L'Industrie Chimique Belge	Fédération des Industries Chimique de Belgique, Brussels. Monthly since 1952. Vol. 18 (1953). Applied chemistry abstracts.
135. Ion (Revista española di química aplicada)	Hermanos Bécquer, Madrid. Monthly. Vol. 14 (1954). Extensive abstracts and patent review sections.
136. Kolloid Zeitschrift (incl. Kolloid-Beihefte)	Verlag Dietrich Steinkopff, Darmstadt. Monthly. Vols. 126–129 (1952). Extensive abstracts ("Referate") section.
137. Österreichische Chemiker-Zeitung (Wiener Chemiker-Zeitung)	Springer-Verlag, Vienna. Monthly double numbers. Vol. 55 (1954). Abstract section ("Zeitschriftenschau").
138. Química Industrial (Uruguay)	Asociación de Químicos Industriales del Uruguay, Montevideo. Approx. quarterly. Vol. 3 (7th year) (1952). Classified abstracts section and translations.

139. Referativnyi Zhurnal, Khimiya (Russian Chemical Abstracts)	Soviet Institute of Scientific Information, Moscow. Semimonthly. 50,000 (?) abstracts per year. Author index in each issue. Annual subject index. Started Oct., 1953.
140. Review of Technical & Economics Literature (Přehled Technické a Hospodařské Literatury)	Technical & Economical Information Center, Prague. 12,000 abstracts per year, 600 journals. Annual author and subject indexes. Vol. 10 (1953).
141. Revista de Química Industrial (Rio de Janeiro)	Vera Maria de Freitas, Rio de Janeiro. Monthly. Vol. 22 (1953). Abstracts (Abstratos químicos) of Brasilian journal articles.
142. La Revue des Produits Chimiques et l'Actualité Scientifique	Centre du Livre Française, Paris. Monthly double numbers. Vol. 56 (1953). Abstracts, book reviews, etc.

III. General and Specific Science Publications Including or Related to Chemistry

A. Biological Sciences

143. Biological Abstracts	Biological Abstracts, University of Pennsylvania, Philadelphia, Pa. 10× per year. 27,000 abstracts per year, 2500 journals. Annual author, subject, geographical, geological, and systematic indexes. Vol. 28 (1954).
144. Current Abstracts of Scientific & Technical Literature	General Foods Corp., Hoboken, N. J. Semimonthly. 1800 abstracts per year.
145. Food Science Abstracts	Dept. of Scientific & Industrial Research, London. Bimonthly. Annual indexes. Vol. 23 (1951).
146. Pest Control	Trade Magazines, Inc., Cleveland, Ohio. Bimonthly. 200 abstracts per year in patent section. Vol. 19 (1951).
147. Squibb Abstract Bulletin	E. R. Squibb & Sons, Brooklyn, N. Y. Weekly. 5000 abstracts per year, 600 journals. Annual author index. Vol. 26 (1953).
148. Stain Technology	Biotechnical Publications, Geneva, N. Y. Quarterly. Vol. 26 (1951). Abstracts and related material.

B. Technical and Engineering Sciences

Domestic Services

149. Battelle Technical Review	Battelle Memorial Institute, Columbus, Ohio. Monthly. 15,000 abstracts per year, 800 journals. Annual author and subject indexes. Vol. 3 (1954).
150. Bibliography of Technical Reports (formerly also Bibliography of Scientific & Industrial Reports)	Office of Technical Services, Dept. of Commerce, Washington, D. C. Monthly. 3000 to 4000 annotations per year. Semiannual subject indexes. Vols. 21/22 (1954).
151. Engineering Index	Engineering Index, Inc., New York, N. Y. 25,000 abstracts per year, 1200 journals. Annual author and subject indexes.
152. Engineer's Digest	Engineer's Digest Publications, Inc., New York, N. Y. Monthly. 250 abstracts per year, 650 journals. Annual and pentennial author and subject indexes.
153. Highway Research Abstracts	Highway Research Board, National Research Council, Washington, D. C. 11× per year. 250 abstracts per year. No index. Vol. 24 (1954).
154. Materials & Methods	Reinhold Publishing Corp., New York, N. Y. Monthly. 200 abstracts per year in "News Digest" and similar sections. Vols. 39/40 (1954).
155. NACA Research Abstracts	Natl. Advisory Committee for Aeronautics, Washington, D. C. Irregular (1–3 numbers per month). 600 abstracts per year. Cumulative indexes of all previous NACA research papers for 1915–49 and 1949–May, 1951. No. 56 (Jan. 13, 1954).
156. NRL Library Bulletin	Naval Research Laboratory, Washington, D. C. Weekly. 16,000 indicative, analyzed abstracts per year. No index. No. 638 (Jan. 8, 1954).
157. Nuclear Science Abstracts	Technical Information Service, Atomic Energy Commission, Oak Ridge, Tenn. Semimonthly. 4500 abstracts per year, 800 journals. Semiannual and cumulative indexes for vols. 1–4 and 5–10. Vol. 8 (1954).
158. Prevention of Deterioration Abstracts (continuation of Tropical Deterioration Bulletin)	Prevention of Deterioration Center, Natl. Research Council, Washington, D. C. Monthly in loose-leaf form. 1000 abstracts per year, 150 journals plus unpublished material. Annual author and subject indexes. Also monthly library *Advance List.* Vol. 11 (July, 1953–June, 1954).
159. Science & Technology	Carnegie Library, Pittsburgh, Pa. Quarterly. 1500 abstracts per year.
160. Technical Data Digest (CADO) (merged with 161 into Title Announcement Bulletin)	Central Air Documents Office, Wright-Patterson Air Force Base, Dayton, Ohio. Monthly up to 1953. 4000 abstracts per year. Annual Index.
161. Technical Information Pilot (merged with 160 into Title Announcement Bulletin)	Technical Information Division, Library of Congress, Washington, D. C. Irregular (approx. 7× per month) up to 1953. 8000 abstracts per year. Quarterly and annual subject indexes. Source and subject heading indexes in each issue.
162. Technical Survey	Technical Survey, Newark, N. J. Weekly. 15,000 abstracts per year.

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163. Abstracts of the Latest Engineering Literature (Saishin Kogaku Bunken Tekiroku Tsushin)	Tokyo. 16,500 abstracts per year, 400 journals.
164. Building Literature (Bygglitteratur)	Bygglitteratur, Stockholm. Monthly. 1800 abstracts per year, 250 journals. No index.
165. Building Science Abstracts	Dept. of Scientific & Industrial Research, London. Monthly. 1800 abstracts per year, 350 journals. Annual author and subject indexes. Vol. 23 (1950).
166. Buletinul de Documentare Tehnica	Roumanian Institute of Bibliography, Documentation & Technical Publishers, Bucharest. Monthly. 6000 abstracts per year, 600 journals. No index.
167. Bulletin de Documentation Technique	Service Technique de la Direction Generale de la Société Nationale des Chemins-de-Fer, Paris. Monthly.
168. Documentation Technique	Centre de Documentation, Paris. Bimonthly. 2000 abstracts per year.
169. Documentazione d' Ingeneria	Rome. 7000 abstracts per year, 140 journals.
170. Electrical Engineering Abstracts (Part B of Science Abstracts)	Institution of Electrical Engineers, London. Monthly. 3000 abstracts per year, 400 journals. Annual author and subject indexes.
171. Journal of Scientific & Industrial Research	Council of Scientific & Industrial Research, New Delhi, India. Monthly, in two parts. Abstracts and patent review sections. Vol. 13 (1954).
172. KLM Literatuuroverzicht	Royal Dutch Airlines, Amsterdam. Weekly. 4000–8000 abstracts per year. No index.

173. Physics Abstracts (Part A of Science Abstracts) — Institution of Electrical Engineers, London. Monthly. 7500 abstracts per year, 400 journals. Annual author and subject indexes.

174. Railway Engineering Abstracts — Institution of Civil Engineers, London. Monthly. 1200 abstracts per year, 40 journals. Annual author and subject indexes.

175. Revue Générale de l'Electricité — Comité Electrotechnique Français & Union Technique de l'Electricité, Paris. Monthly. 1000 abstracts per year in extensive abstracts section.

176. Weekly Abstracts of the Electrical Research Association — British Electrical & Allied Industries Research Association, Leatherhead (Surrey). Weekly. 1800 abstracts per year. No index.

C. Patent Literature

Patent journals publishing abstracts, excerpts, or patent claims:

177. Australian Official Journal of Patents, Trademarks & Designs — Dept. of Patents, Canberra, A.C.T. Weekly. 4000 abstracts per year. Vol. 21 (1951).

178. Canadian Patent Office Record & Register of Copyrights & Trademarks — Canadian Patent Office, Ottawa. 8000 abstracts per year.

179. Gazeta de la Propriedad Industrial — Mexico. 500 abstracts per year.

180. Norsk Tidende for det Industrielle Rettsvern — Oslo. Weekly. 1500 abstracts per year in *Teknisk Ukeblad.* Vol. 41 (1951).

181. The Official Gazette — U. S. Patent Office, Dept. of Commerce, Washington, D. C. Weekly, in 12 vols. per year. 44,000 patent claims per year. Vol. 678 (Jan., 1954).

182. The Official Journal (Patents for Inventions. Abridgments of Specifications) — Gt. Brit. Patent Office, London. Weekly. 20,000 excerpts per year. No. 3229 (Jan., 1951).

183. Patentes y Marcas — Argentina. 5000 abstracts per year.

184. Recueil des Brevets d'Invention — Service de la Propriété Industrielle, Brussels. Monthly. 7000 abstracts per year. Vol. 1953 (1953).

Patent journals publishing patent lists:

185. Bulletin Official de la Propriété Industriale — Published in Paris.

186. Bulletino dei Brevetti per Invenzioni, Modelli e Marchi — Published bimonthly in *Il Monitore Industrial,* Milan.

187. Dansk Patenttidende — Published weekly by Direktoret for Patent- og Varemaerkevaesenet, Copenhagen.

188. Memorial du Grand-Duché de Luxembourg — Luxemburg.

189. Núcleo (formerly Nuevo Industria Química) — Madrid. Monthly.

190. Octrooiraad Nederland — Bureau voor de Industriële Eigendom, The Hague. Irregularly.

191. Patentblatt (formerly also Auszüge aus den Patentschriften) — Deutsches Patentamt, Munich. Weekly. Suspended between 1945–50. Vol. 70 (Feb., 1950).

192. Patent-Liste (Liste des Brevets; Lista dei Brevetti) — Switzerland.

193. Patentní Vestník — Prague.

194. Svensk Tidskrift för Industrielli Rättsskyd — Stockholm. Biweekly, in *Industritidningen Norden.*

195. Szabadalmi Közlöny (Bulletin des Brevets & Bulletin Central des Marques) — Budapest. Monthly.

196. Tokkyo Koho (Official Patent Reports) — Hatsumei Kyokai c/o Patent Office, Tokyo. Irregular.

197. Wiadomosci Urzedu Patentowego Miesiecznik — Poland.

D. General Science

198. Book Review Digest — H. W. Wilson Co., New York, N. Y. Monthly. 4000 reviews per year.

199. Dissertation Abstracts (formerly Microfilm Abstracts) — University Microfilms, Ann Arbor, Mich. Bimonthly. 200 abstracts per year. Triennial indexes. Vol. 13 (1953).

200. European Scientific Notes — Assistant Naval Attaché for Research, U. S. Embassy, London. Distributed by Naval Research Section, Library of Congress, Washington, D. C. Approx. monthly. 250 abstracts and related items per year. Annual title heading index.

201. FIAT Review of German Science — Technical Field Information Agencies, Military Government, West German Occupation Zone. Published in 1948. Covers German progress between 1939–46.

202. Guide to Russian Scientific Periodical Literature — Brookhaven National Laboratory, U. S. Atomic Energy Commission. 400 abstracts and 6000 bibliographic entries per year, 30 journals. Annual title index.

203. List of Documents Received from British Commonwealth Sources — British Commonwealth Scientific Office, U.S.A. Monthly. 2000 annotated entries per year. No index.

204. Monthly List of Russian Accessions — Exchange and Gift Section, Library of Congress, Washington, D. C. Monthly. 750 entries per year.

205. New Technical Books — New York Public Library, Science and Technology Division. Bimonthly. 450 entries per year.

206. Technical Book Review Index — Special Libraries Assn., New York, N. Y. Monthly. 1600 entries per year.

207. Translated Contents Lists of Russian Periodicals — Dept. of Scientific & Industrial Research, London.

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The Literature in the Field of Cellulose and Its Related Materials—Its Definitive Literature

E. C. JAHN and C. V. HOLMBERG

THE definitive literature on cellulose and related materials is not extensive when compared to several other fields of chemistry. Furthermore, it is comparatively recent, since most of the books have been written since 1920. Cellulose literature developed rather slowly, beginning at the turn of the century. Outstanding among some of the early publications are Cross and Bevan's monograph on "Cellulose" and Schwalbe's "Chemie der Cellulose." Some of the early works, during the past century and the early part of this century on plant biochemistry and physiology, contain considerable information on cellulose. An outstanding example is Czapek's "Biochemie der Pflanzen." Early knowledge of cellulose, therefore, frequently appears in general books dealing with plants.

Even today cellulose is frequently treated in some detail in books dealing with a broader subject, such as on polysaccharides, biochemistry, or polymers, or in books dealing with a special phase of chemistry such as colloids, plant analysis, rheology, etc. Such books, then form a part of the cellulose literature, even though they are not dealing specifically or only with cellulose.

There are no sharp boundaries to the field of cellulose chemistry, and in the compilation of the literature, it is necessary to set up certain arbitrary rules and to use some personal judgment. In this case, we have chosen to include literature not only dealing with cellulose and its derivatives, but also with those materials associated with cellulose in the cell wall. Therefore, books concerned with the chemistry and properties of lignin, wood, various plants and plant tissues, plant fibers, and hemicelluloses are included in the strictly definitive literature. We have omitted, however, books dealing only with the extraneous substances found in wood and plants, such as tannins, resins, volatile oils, dyes and pigments, mineral substances, alkaloids, etc. The chemistry of such materials is not related to the chemistry of cellulose. Books dealing with wood or plant chemistry often contain chapters on these extraneous constituents.

Besides the strictly definitive literature on cellulose and associated materials, we have included a separate list of related literature containing information bearing on cellulose, such as books on carbohydrates, plants, polymers, etc. This list of related literature is not presumed to be complete, but includes the more important works bearing on cellulose chemistry.

Bulletins, dissertations, reports, and short monographs are discussed in another paper in this symposium. Most bulletins and reports are issued by various research institutes, experiment stations, government agencies, and universities as regular series. For example, the Reports of the Imperial Industrial Research Institute, Osaka, Japan, contain the several reports of P. P. von Veimarn on his dispersoidological investigations during the Mid-Twenties. The U. S. Department of Agriculture, Forest Service (including Forest Products Laboratory) publishes bulletins and reports. The U. S. Department of Commerce, National Bureau of Standards, issues a series of research papers. The Department of Resources and Development, Forestry Branch (including Forest Products Laboratories of Canada), issues research bulletins. This is true of most government centers of research. The Engineering

E. C. JAHN, and C. V. HOLMBERG, State University of New York, College of Forestry, Syracuse, N. Y.

Science Academy of Sweden (Ing. Vetenskaps Akad.) publishes a series of reports, many on the subject of cellulose and wood chemistry. Many universities and university experiment stations publish series of bulletins. These various bulletin and report series are reviewed in the abstract literature.

Dissertations in Europe are generally published either in book form or as short monographs. The abstract literature, therefore, refers more frequently to European dissertations than it does to American theses. Various lists of American doctoral theses are available, however. For example, Wilson & Co., New York, compiles yearly "Doctoral Dissertations Accepted by American Universities" for the Association of Research Libraries. Also, University Microfilms, Ann Arbor, Mich., publishes in magazine form "Doctoral Dissertations from Leading Universities."

Many associations and organizations also publish reports, bulletins, and monographs, some of which deal with cellulose, wood, and related materials. Among these are the Technical Association of the Pulp and Paper Industry, the Northeastern Wood Utilization Council, the Food and Agricultural Organization of the United Nations, and many others.

Definitive literature is normally considered the book literature on a subject. We have, therefore, attempted to develop a comprehensive list of books on the chemistry, properties and technology of cellulose and associated materials. This includes books on cellulose, fibers, wood, lignin, plants, cellulose derivatives, pulp and paper, textiles, wood distillation, rayon, staple fiber, and on other specialized aspects of the chemistry and technology of cellulose and related materials. We make no claim that this list is complete, but it covers most of the works on cellulose. In many cases only secondary sources of information were available, which may introduce a few minor errors. Older books were frequently revised and published as new editions many times over a period of years. No attempt has been made to record every revision and every edition, but an attempt has been made to include the latest and one of the early editions.

In summation, the literature list appended to this paper is classified as follows:

I. Definitive literature on cellulose
II. Related literature containing information bearing on cellulose

LITERATURE LIST

I. Definitive Literature on Cellulose

Algerino, A., "Chimica Analitica Applicata Allíndustria Tessile e Tinctoria." Vol. I. Analisi tessile. 2nd ed. Milan, U. Hoepli, 1948. 326 pp.

Am. Soc. Test. Materials, "ASTM Standards on Paper and Paper Products, and Shipping Containers." Philadelphia, ASTM, 1953. 396 pp.

Am. Soc. Test. Materials, "ASTM Standards on Plastics," Philadelphia, ASTM, 1954. 760 pp.

Am. Soc. Test Materials, "ASTM Standards on Textile Materials." Philadelphia, ASTM, 1953. 688 pp.

Andés, L. E., "Zelluloid und Seine Verarbeitung." Wien, 1908. 374 pp.

Anon., "Auszüge aus der Literatur der Zellstoff und Papierfabrikation," 1928. Teil I. Chemischer Teil. Berlin, O. Elsner, 1929. 195 pp.

Astbury, W. T., Fundamentals of Fiber Structure." London, Oxford Press, 1933. 187 pp.

Avram, M. H., "The Rayon Industry." New York, D. Van Nostrand, 1927. 622 pp.

Battegay, Martin, and Denivelle, Leon, "La Cellulose." 2 parts. Paris, Hermann and Cie, 1935. 71 and 61 pp.

Beadle, Clayton, "Chapters on Paper-making." Five volumes. London, Crosby, Lockwood and Co., 1901, 1904, 1906, 1907, 1908.

Behrens, H., "Anleitung zur Mikrochemischen Analyse der Wichtigsten Organischen Verbindungen." (4 Hefte.) Hefte 2. Die wichtigsten organischen Faserstoffe. 2 Aufl. Hamburg, 1908.

Beka, K. O., "Provyerha Nyekotornikh Sposobov Opredyeleniya Khetahalyi." (Test of certain methods for determining cellulose.) Yur'ev. 1900. 105 pp.

Beltzer, F. G., and Persoz, J., "Les Matieres Cellulosiques" Paris, C. Bearnger. 1911.

Bergström, Hilding, "Produkter ur Trä." Stockholm, Kolningslabs. Pub., 1949, 280 pp.

Bergstrom, H., and Wesseln, G., "Om Träkolning." Stockholm, Kungl. Boktryckeriet, 1918. 322 pp.

Bernadon, John B., "Nitrocellulose . . . and the Theory of the Cellulose Molecule." New York, Wiley, 1901. 200 pp.

Bersch, Josef, "Cellulose, Celluloseproducte und Kautschuksurrogate." Vienna, 1904. 404 pp. English translation by Wm. T. Brannt. Philadelphia, Baird and Co., 1904. 345 pp.

Bersch, Josef, "Die Verwertung des Holzes auf Chemischen Wege." 3 Aufl., Wien und Leipsig, A. Hartlebens Verlag, 1912. 331 pp.

Bertin, A., "Principaux Emplois Chimiques du Bois." Paris, La Vie Technique et Industrielle, 1924. 126 pp.

Böckman, F., "Celluloid, Its Raw Material and Manufacture." Translated from the 3rd rev. ed. by Charles Salter. New York, Van Nostrand, 1907. 113 pp. 2nd Eng. ed. revised by H. B. Stocks. London, Scott, Greenwood, 1921. 188 pp.

Bodenbender, H. G., "Zellwolle." 2nd ed., Berlin, the Author, 1936. 480 pp.

Bonwitt, G., "Des Celluloid und seine Ersatzstoffe." Berlin, Union Deutsche Verlagsges., 1933. 813 pp.

Bornemann, Georg, "Ueber Cellulose und Neuere Umwandlungsproducte Derselben." Beberach, 1901.

Brandt, Sven, "Textilaere, Materialaere." Odense, Tek. Skoleforenings Forlag, 1953. 143 pp.

Brasseur, H., Les Rayons X et Leurs Applications." Paris, Masson et Cie, 1945. 366 pp.

Brauns, Friedrich Emil, "The Chemistry of Lignin." New York, Academic Press, 1952. 808 pp.

Bugge, G., "Die Holzverkohlung und ihre Erzeugnisse." Berlin und Leipsig, Walter de Gruyter, 1925, 140 pp.

Bugge, G., "Industrie der Holzdestillations Producte." Pt XV. Technische Fortschrittsberichte. Dresden, T. L. Steinkopff, 1927. 216 pp.

Bumcke, Gebhardt, "Ueber Cellulose." Berlin, Rostock. 1909.

Bunbury, H. M., "Destructive Distillation of Wood." London, Benn Bros., 1923. 320 pp. German edition: Berlin, Springer, 1925. 340 pp.

Buratti, Romolo, "Chimica Delle Fibre Tessili e dei Loro Trattamenti Industriali. Note di Chimica Tessile ed Affine." Milan, L'Industrica tessile e tinctoria, 1922. 395 pp.

Butschli, O., "Untersuchungen an Gerinnungschaümen. Sphärokrystallen und Structure von Cellulose." 1894.

Buttrey, D. N., "Cellulose Plastics." London, Cleaver-Hume, 1947. 127 pp.

Buttrey, D. N., "Cellulose Plastics." New York, Interscience Pubs., 1950. 130 pp.

Caille, A., "Contribution à l'Étude des Éthers Cellulosignes." Rouen, A. Desvages, 1932.

Carpenter, Charles, and Leney, Lawrence," 91 Paper Making Fibers." Syracuse, State Univ. of N. Y. College of Forestry, 1952. 152 pp. 382 photomicrographs.

Casey, James P., "Pulp and Paper—Chemistry and Chemical technology. I. Pulping and Papermaking. II. Properties of Paper and Converting." New York, Interscience Publ., 1952. 1405 pp.

Cesconi, Giovanni, "La Cellulosa." Rome, Soc. An. Tipografica Edizione Romano, 1939. 250 pp.

Champetier, G., "Matériaux de Synthése. Dérivés Cellulosiques." Paris, Dunod, 1947. 275 pp. 2nd ed. 1953.

Chaudhuri, Tarini C., "Modern Chemistry and Chemical Industry of Starch and Cellulose." Calcutta, Butterworth. 156 pp.

Christiansen, C., "Ueber Natronzellstoff, seine Herstellung und Chemischen Eigenscheften," Berlin, 1913. 162 pp.

Clapperton, R. H., "Modern Papermaking," 3rd ed. Oxford, Basil Blackwell, 1952. 526 pp.

Clapperton, R. H., "Paper: A Historical Account of its Making by Hand from the Earliest Times down to the Present Day," Oxford, Basil Blackwell, 1934. 156 pp.

Clapperton, R. H., and Henderson, W., "Modern Papermaking." 2nd ed. Oxford, Blackwell & Mott Ltd., 1941. 376 pp. 1st ed., 1929.

Clément, L., and Rivière, C., "Die Zellulose. Die Zelluloseverbindungen u. ihre Techn. Anwendung. Plastische Massen." Berlin, Springer, 1923. 275 pp.

Clément, L., and Rivière, C., "La Cellulose et les Ethers Cellulosiques." Paris, Bearnger, 335 pp. German edition: Berlin, Springer, 1923. 291 pp.

Cooper, F. J., "Textile Chemistry: An introduction to the Chemistry of the Cotton Industry." New York, Dutton, 1923. 235 pp.

Correa, M. P., "Fibras Texteis e Cellulose." Rio de Janeiro. Imprensa Nacional, 1919. 276 pp.

Cross, C. F., Bevan, E. J., and Beadle, "An Outline of the Chem-

istry of Structural Elements of Plants." New York, Longmans, Green, 1916. 328 pp.
Cross, C. F., and Bevan, E. J., "A Textbook of Papermaking." 5th ed., London, Spon; New York, Spon and Chamberlain, 1920. 527 pp.
Cross, C. F., and Bevan, E. J., "Cellulose." London, Longmans, Green and Co., 1895. 320 pp. Rev. ed. 1916. 328 pp., 1918. 348 pp.
Cross, C. F., and Bevan, E. J., "Researches on Cellulose," 1895–1900. New York, Longmans, 1901. 180 pp. Vol. II (1900–1905, Longmans, 1906. 184 pp.)Vol. III (1905–1910, Longmans, 1912. 173 pp.) Vol. IV (1910–1921, Longmans, 1922. 250 pp.).
Cross, C. F., Bevan, E. J., and Sindall, R. W., "Wood Pulp and Its Uses." London, Constable, 1911. 250 pp.
Czapek, Friedrich, "Biochemie der Pflanzen." 2nd ed. Jena, Fischer, 1913–1921. 3 V. 3rd ed., 1922–25. 3 V.
Dannerth, F., "The Methods of Textile Chemistry." New York, Wiley, 1908. 164 pp.
DeVries, H., "On the Elastic and Optical Properties of Cellulose Fibres." Utrecht, Schotanus and Jens, 1953. 111 pp.
Dieckmann, R., "Die Fabrikation des Zellstoffes aus Holz. I. Tech. Sulfitzellstoff. Berlin, Elsner, 1923, 367 pp.
Diserens, L., "Neueste Fortschritte und Verfahren in der Chemischen Technologie der Textilfasern." Part I. Vol. I. Basle, Verlag Birkhauser, 1946. 653 pp. T. II. 1948. 727 pp.
Dorée, C., "Les Méthodes de la Chimie de la Cellulose Comprenant Des Methodes a Recherches sur les Celluloses Composées." 2nd ed. Paris, H. Dunod, 1949. 578 pp.
Dorée, Charles, "The Methods of Cellulose Chemistry." 2nd ed. London, Chapman and Hall, Ltd., 1947. 543 pp. 1st ed. 1933. 499 pp.
Dragendorff, G., "Die Qualitative und Quantitative Analyse von Pflanzen und Pflanzenteilen." Göttingen, Vandenhöck and Ruprechts Verlag, 1882. Engl. ed. translated by H. G. Greenish, New York, G. E. Stochert, 1909. 280 pp.
Dropisch, Bernhard, "Holzstoff und Holzcellulose, ihre Herstellung und Verarbeitung fur die Papierfabrikation." Weimar, Voight, 1879. 98 pp.
Dubosc, André, "Les Ethers Cellulosique. Premiere Partie, Les Ethers Minéraux et la Cellulose, Vol. I. La Nitrocellulose et le Celluloid." Paris, A. D. Cillard, 1920. 344 pp.
Dumesny, P. and Noyer, J., "L'industrie Chimique des Bois. Leurs Dèrivés et Extraits Industriels." Paris, B. Tignol, 1906. 406 pp. Engl. Transl. London, Scott, Greenwood, 1908. 320 pp., 2nd ed. 1921. 357 pp.
Dupont, G., "Distillation du Bois." Paris, Gauthier-Villars & Cie, 1924. 284 pp.
Echeverria, I., "Celulosa Leñosa; su Desarrolo Industrial Obtención al Bisulfito, Aplicación a la Seda Artificial." Madrid, Servicio forestal investigacione y experiencios, 1929. 110 pp.
Eggert, Johann, "Die Herstellung und Bearbeitung der Viscose unter bes. Berücks, d. Kunstseidefabrikation." Berlin, Springer, 1931. 244 pp. 1st ed. 1926. 92 pp.
Eggert, Johann, "Filmgebilde aus Viskose," Halle, W. Knapp, 1932. 300 pp.
Ekenstam, "Alf af. Über die Cellulose-Lösungen in Mineralsauren. Beiträge zur Konstitutions-Ermittlung der Cellulose." Lund, Carl Bloms Boktryckeri, 1936. 157 pp.
Engels, Otto, "Futtercellulose, ihre Gewinnung und Verwertung," Augsburg, H. Ziolkowsky, 1948. 112 pp.
Faust, O., editor. "Celluloseverbindungen und Einige Besonders Wichtige Bisher Nicht Bearbeitete Verwendungsgebiete Dargestellt an Hand der Patent-Weltliteratur." Berlin, Springer, 1931. 145 pp.
Faust, O., "Celluloseverbindungen und ihre Besonderers Wichtigen Verwendungsgebiete." 2 vols., Berlin, Springer, 1935. About 3100 pp.
Faust, O., "Kunstseide." 3rd ed. Dresden, T. Steinkopff, 1928. 167 pp. 4th & 5th ed. 1931. 289 pp.
Freudenberg, Karl, "Tannin, Cellulose, Lignin." Berlin, Springer 1933. 165 pp.
Fuchs, Walter, "Die Chemie des Lignins." Berlin, Julius Springer, 1926. 327 pp.
Fundamental Research Committee, TAPPI. "Nature of the Chemical Components of Wood." TAPPI Monograph Series No. 6. New York, Technical Association of the Pulp and Paper Industry, 1948. 234 pp.
Gabillion, R., "Soies Artificielle et Matierés Plastiques." Paris, Armand Colin, 1931. 204 pp.
Georgievics, G. V., "Lehrbuck der Chemisches Technologie der Gespinnstfasern." Leipsig. und Wein, F. Deuticke, 1907–8. 399 pp. 2nd ed. 1913. 553 pp.
Gottstein, L., "Holzzellstoff in seiner Anwendung für die Papier und Textil-Industrie und die bei seiner Herstellung entstehender Abwässer." 1904.
Götze, Kurt, "Chemifasern nach dem Viskoseverfahren. 2 neuearb. Aufl. von Kunstseide und Zellwolle nach dem Viscoseverfahren." Berlin, Springer-Verlag, 1951. 739 pp. 1 Aufl, 1940. 644 pp.
Goulding, E., "Cotton and Other Vegetable Fibers." London, John Murray, 1917. 231 pp.
Grafe, V., editor. "Die Textilien Chemische Technologie der Zellulose." Stuttgart, C. E. Poeschel, 1928. 770 pp.
Gralén, N., "Sedimentation and Diffusion Measurements on Cellulose and Cellulose Derivatives." Uppsala, Almqvist & Wiksells, 1944. 115 pp.
Grant, Julius, "A Laboratory Handbook of Pulp and Paper Manufacture." London, 1942. 320 pp.
Grant, Julius, "Wood Pulp and Allied Products." 2nd ed. London, Leonard Hall Ltd., 1947. 312 pp.
Greiffenhagen, Erich, "Kunstseide. Vom Rohstoff bis zum Fertigfabrikat." Berlin, L. Schottlaender & Co., 1928. 115 pp.
Griffin, R. B., and Little, A. D., "The Chemistry of Paper Making, Together with the Principles of General Chemistry." New York, Lockwood, 1894. 517 pp.
Gueneau, L., "La Soie Artificeille." Paris, Dunod, 1927. 232 pp.
Guillemonat, A., "Le Bois, Matière Premiére de la Chimie Moderne." Paris, Dunod, 1942. 136 pp. 2nd ed. 1950. 193 pp.
Hägglund, Erik, "Cellulose ur Ved; Papper Papp och Kartong; Socker ur trä." (No date or printer's name given.) 211 pp.
Hägglund, Erik, "Chemistry of Wood." New York, Academic Press, 1951. 631 pp.
Hägglund, Erik, "Die Hydrolyse der Zellulose und des Holzes." Stuttgart, Enke, 1915. 456 pp.
Hägglund, Erik, "Die Fabrikation des Zellstoffs aus Holz." Vol. II part 2. Natronzellstoff. Berlin, 1926. 360 pp.
Hägglund, Erik, "Die Sulfitablauge und ihre Verarbeitung auf Alkohól." Braunschweig, Viewig, und Sohn, 1920.
Hägglund, Erik, "Holzchemie." 2. Aufl. Leipzig, Akademische Verlagsges., 1939. 397 pp. 1. Aufl., 1928. 275 pp.
Hall, A. J., "Cotton Cellulose." New York, Van Nostrand, 1924. 228 pp.
Hall, A. J., "The Chemistry and Technology of Artificial Silks." London, Ernest Benn, 1927.
Hannig, Max., "Ueber die Destillation von Zellulose und anderen Stoffen unter Wasserstoffdruck mit Katalysatoren." Weida i. Thur, Thomas & Hubert, 1925.
Harper, H., "Introduction to Textile Chemistry." London, Macmillan, 1921. 189 pp.
Harper, W. B., "Utilization of Wood Waste by Distillation." New York, Van Nostrand, 1908. 156 pp.
Hartsuch, B. E., "Introduction to Textile Chemistry." New York, Wiley, 1950. 401 pp.
Hartsuch, B. E., "Textile Chemistry in the Laboratory." New York, Wiley, 1950. 72 pp.
Haug, Alfons M., "Uber die Natur der Cellulose aus Getreidestroh." Berlin, Carl Hoffmann, 1925. 77 pp.
Hawley, L. F., "Wood Distillation." New York, Chemical Catalog Co. (now Reinhold), 1923. 136 pp.
Hawley, L. F., and Wise, L. E., "The Chemistry of Wood." New York, Chem. Catalog Co. (now Reinhold), 1926. 334 pp.
Heerman, P., editor. "Enzyklopädie der Textilchemischen Technologie." Berlin, Springer, 1930. 970 pp.
Heerman, P., "Färberer- und Textilchemische Untersuchungen." Berlin, Springer, 5th ed. 1929. 435 pp., 7th ed. 1940. 419 pp.
Hermans, P. H., "Contribution to the Physics of Cellulose Fibers.' New York, Elsevier Publ. Co., 1946. 222 pp. (Monographs on the progress of research in Holland during the war, No. 3).
Hermans, P. H., "Physics and Chemistry of Cellulose Fibres." New York, Elsevier Publ. Co., 1949. 534 pp.
Herzog, R. O., editor. "Kunstseide." Berlin, Springer, 1927. 354 pp.
Hess, Kurt, "Die Chemie der Zellulose und ihrer Begleiter." Leipzig, Akademische Verlagsgesellschaft, 1928. 836 pp.
Hess, K. P., "Textile Fibers and Their Use." 4th ed. Philadelphia, Lippincott, 1948. 600 pp.
Hess, K., and J. R. Katz., "Die Chemie der Zellulose." Leipzig. Adademische verlag., 1928. 836 pp.
Heuser, Emil, "Lehrbuch der Cellulosechemie." 3rd ed. Berlin, Borntraeger, 1927. 278 pp. (2nd ed., 1923. 211 pp.; 1st ed., 1921. 188 pp.).
Heuser, Emil, "The Chemistry of Cellulose." New York, Wiley, 1944. 660 pp.
Heuser, E., editor. "Technik und Praxis der Papierfabrikation." I. Heuser and Opfermann, II: 1. Dieckmann: "Sulfitzellstoff," II: 2. Hagglund: "Natronzellstoff," III: "Die Roh- und Halbstoffes." 1 and 2 Opfermann & Hochberger: "Das Bleichen von Zellstoff." Berlin.
Heuser, Emil, and Opfermann, E., "Die Geschicte des Papiers." Vol. I. Die Rohund Halbstoffes der Papierfabrikation." Berlin, Elsner, 1929. 360 pp.
Heuser, Emil, West, C. J., and Esselen, G. J., "Textbook of Cellulose Chemistry." New York, McGraw-Hill, 1924. 212 pp.
Hottenroth, V., "Artificial Silk." Translated from German by E.

Fyleman. New York and London, D. Pitman, 1928. 421 pp.
Hottenroth, V., "Die Kunstseide." 2nd ed. Leipsig, S. Hirzel, 1930. 500 pp. 1st ed. 1926. 492 pp.
Hoyer, Fritz, "Die Cellulosefabrikation." Berlin, M. Krayn, 1925. 316 pp.
Hoyer, Fritz, "Die Strohzellstoffabrikation." Berlin, M. Krayn, 1926. 346 pp.
Hubbard, Ernst, "The Utilization of Wood Waste." Transl. from 2nd German ed. London, Scott, Greenwood & Son, 1915. 192 pp.
Industriens Utrédningsinsittut. "Tillvaratagande och Förädling av Mindervärdikt Virke Samt Avfalls-och Biprodukter i Skogsindustrien (Norrlandsutredningen)." Uppsala, Almqvist & Wiksells Boktryckeri AD., 1942. 328 pp.
Jentgen, H., "Laboratoriumsbuch für die Kunstseide- und Ersatzfaserstoff-Industrie." Halle, W. Knapp, 1923. 106 pp.
Joint Textbook Com. of the Paper Ind., U. S. and Canada, "Manufacture of Pulp and Paper." A textbook of modern pulp and paper practice. Vol. III. Properties of pulpwood; preparation of pulpwood; manufacture of mechanical, sulphite, and alkaline pulps; treatment of pulp; bleaching of pulp; testing of pulp. 3rd ed. New York, McGraw-Hill Book Co., 1937. 827 pp.
Jorgensen, Leif, "Studies on the Partial Hydrolysis of Cellulose." Oslo, Trykt Hos Emil Moestue A/S, 1950, 176 pp.
Karrer, P., "Polymere Kohlenhydrate." Leipzig, Akademische Verlag., 1925. 285 pp.
Kausch, O., "Handbuch der Azetylzellulosen." Munich, J. F. Lehmann, 1933. 274 pp.
Khouvine, Yvonne, "Cellulose et Bactéries. Décomposition et Synthèse. Paris, Hermann & Cie, 1934, 44 pp.
Klar, M., "Technologie der Holzverkohlung." Berlin, Springer, 1903. 246 pp. 2nd ed. 1910. 429 pp. English translation by A. Rule. London, Chapman & Hall, 1925. 496 pp.
Klar, M., "Traité Pratique des Emplois Chimiques du Bois." Translated by L. Gautier. Paris, Beranger, 1904. 345 pp.
Klason, P., "Beitrage zur Kenntniss der Chemischen Zusammensetzung des Fichtenholzes." Berlin, 1911. 42 pp.
Klason, P., "Ber. Hauptversammlung des Vereins der Zellstoff und Papier Chemiker." 1908.
König, J., and Huhn, Fr., "Bestimmung der Cellulose in Holzarten und Gespinstfasern." Berlin, Verlag for Textil-Industrie, 1912.
König, J., and Rump, E., "Chemie and Struktur der Pflanzen-Zellmembran." Berlin, Springer, 1914. 88 pp.
Kränzlin, G., and Marcus A., "Baumwolle." Leipzig, Deutscher Auslandsverlag, 1931. 169 pp.
Krüger, D., "Zellulose-Azetate und die Anderen Organischen Ester der Zellulose." Dresden, Th. Steinkopf, 1933, 391 pp.
Kungliga Tekniska Högskolan. Publikationer fran Organisk-Kemisk. Institutionem, 1946–1950 (bound reprints, mostly on wood chemistry), Stockholm.
Kürschner, Karl, "Zur Chemie der Lignin Korper." Sammlung chemischer und chemischtechnischer Vorträge 28, no. 3/5. 186 pp.
Lange, Otto, "Chemisch-Technische Vorschriften." Vol. II. Fasern, Massen und Schichten. 3rd ed. Leipsig, Otto Spamer, 1923, 1016 pp.
Leeming, Joseph, "Rayon." New York, Chem. Pub. Co., 1949. 203 pp.
Lefranc, J., Berthelot, Ch., and Juin, G., "Les cétones. L'hydrolyse de Matières Cellulosiques." Paris, Hermann & Cie, 1944. 80 pp.
Lehne, A., "Textilchemische Erfindungen," Lieferung. 5. Wittenberg, A. Ziemsen Verlag, 1929.
Lensi, Mario, "La Cellulosa. Applicazioni Industriali e Realizzazioni Autarchiche." Florence, Cya, 1940. 351 pp.
Lensi, M., "La Cellulosa e le Sue Applicazioni Industriali." Firenze, Cya, 1953. 463 pp.
Levy-Hulot, Georges, "L'ànalyse Immédiate des Bois." Paris, Mason et Cie, 1946. 165 pp.
Lieser, Th., "Kurzes Lehrbuch der Cellulosechemie." Berlin-Nikolassee, Gebrüder Borntraeger, 1953. 288 pp.
Lindenmeyer, J., "Die Stapelfaser Sniafil." Munich, Oldenbourg, 1931. 94 pp.
Linder, A., "Kunstseide." 2nd ed. Basel, B. Wepf & Cie, 1929. 53 pp.
Lipscomb, A. G., "Cellulose Acetate." London, E. Benn, 1933. 308 pp.
Lorenz, Walther, "Abriss der Faserstoffchemie." Leipsig, Fackbuckverlag, 1953. 82 pp.
Maddox, H. A., "Paper: Its History, Source and Manufacture," 6th ed. London, Pitman, 1939. 180 pp.
Main, W., "Le Celluloid et Ses Succédanés." Paris, Gauthiers-Villars, 1913. 163 pp.
Main, W., Enduits Cellulosique: Preparation et Application des Peintures, Lacques, Vernis et Apprêts a Base de Nitrocellulose et Acétocellulose." Paris, Gauthier-Villars et Cie, 1929. 216 pp.
Margosches, B. M., Die Viskose, ihre Herstellung, Eigenshaften und Anwendung." Leipsig. 1906.
Mariller, Ch., "Carbonisation des Bois et Carburants Forestiers." Paris, H. Dunod, 1941. 350 pp.
Mariller, Ch., "La Carbonisation des Bois, Lignites et Tourbes," Paris, Dunod, 1924. 347 pp.
Mark, H., "Physik und Chemie der Cellulose." Band I/1 der Tecknologie der Textilfasern, von R. O. Herzog, Berlin, Springer, 1932. 330 pp.
Marsh, John T., "Mercerising." London, Chapman and Hall, 1941. 458 pp.
Marsh, J. T., and Wood, F. C., "An Introduction to the Chemistry of Cellulose," 3rd ed. London, Chapman and Hall, 1945. 525 pp.
Masselon, Roberts and Cillard, "Le Celluloid Fabrikation, Applications, Substituts." Paris, A. D. Cillard, 1910. English translation by Hodgson, H. H., Philadelphia, Lippencott, 1912. 356 pp.
Mathieu, M., "La Gélatinisation des Nitrocelluloses. Réaction Topochimique." Paris, Hermann & Cie, 1935. 76 pp.
Mathieu, M., "La Nitration de la Cellulose. Réaction Topochimique." Paris, Hermann & Cie, 1936. 66 pp.
Mathieu, M., "Réactions Topochimiques. Généralités." Paris, Hermann & Cie, 1936. 58 pp.
Matthews, J. M., "Bleaching and Related Processes as Applied to Textile Fibers and Other Materials," New York, Reinhold, 1921. 676 pp.
Matthews, J. M., "Laboratory Manual of Dyeing and Textile Chemistry." New York, Wiley, 1909. 363 pp.
Matthews, J. Merritt, "The Textile Fibers, Their Physical Microscopical, and Chemical Properties." 2nd ed. New York, John Wiley, 1904. 228 pp. 4th ed. 1924, 1053 pp.
Matthews, J. M., "Matthews' Textile Fibers: Their Physical Microscopical and Chemical Properties." 5th ed. Edited by H. R. Mauersberger. New York, John Wiley, 1947. 1133 pp.
Mauersberger, H. R., and Schwarz, E. W. K., "Rayon and Staple Fiber Handbook." 3rd ed. New York, Rayon Handbook, Co. 1939.
Mauersberger, H. R., "American Handbook of Synthetic Textiles." New York, Textile Pubs., 1952. 1216 pp.
McFarlane, Samuel B., "Technology of Synthetic Fibers." New York, Fairchild Pubs., 1953. 477 pp.
Merck, E., "Chemisch-technische Untersuchungsmethoden für die Zellstoff-und Papier-Fabrikation." Berlin. Verl. Chemie, 1942. 272 pp.
Merideth, R., editor. "Mechanical Properties of Wood and Paper." Vol. III. Deformation and flow. New York, Interscience, 1953. 300 pp.
Meyer, K., and Mark, H., "Der Aufbau der Hochpolymeren Organischen Naturstoffe auf Grund Molecularmorphologischer Betrachtungen." Leipsig, 1930. 264 pp.
Michels, Mario, "Teorica Della Cellulosa." Turin, Cartiere Burgo, 1939. 247 pp.
Mienes, K., "Celluloseester und Celluloseäther unter Besonderen Berücksichtigungen der Benzylcellulose." Berlin, Chem. techn. Verl. Bodenbender, 1934. 124 pp.
Mierzinski, Stanislaus, "Handbuch der Praktischen Papier-Fabrikation." Wein, Hartleben, 1886. 3 V.
Miller, R. N., Swanson, W. H., Bray, M. W., Söderquist, R., Andrews, T. M., and Monsson, W. H., "Chemistry of the Sulfite Process." New York, Lockwood Trade J. Co., 1928. 166 pp.
Moncrieff, R. W., "Artificial Fibers." London, Nat'l. Trade Press. 1950. 314 pp.
Montessus de Ballore, Henry de, "La Fabrication des Celluloses de Papetrie Autres que Celle du Bois." Paris, Dunod et Pinat, 1913. 294 pp.
Mori, A. de, Carbonizzazione e Distillazione del Ligno. Turin, S. Lattes & Co., 1932. 143 pp.
Mortgat, R., "La Fabrication de la Soie Artificielle par le Procéde Viscose." Paris, Dunod, 1929. 600 pp.
Navarro Sagristá, J., "Fabricación de las Pastas de Celulosa." T. III. Alcoy, J. Novarro Sagristá, 1952. 531 pp.
Nägelli, C. von, "Die Stärkekörner. Morphologische, Physiologische, Chemische-Physikalische und Systematische-Botanische Monographie." Zurich, 1858.
Nikitin, N. J., "Khimia Dreveseny" (chemistry of wood). Moscow, Akad. Wiss, U.S.S.R., 1951. 578 pp.
Nilssen, Bailli, "Textilkemi." Stockholm, Bokförlag. 1950. 228 pp.
Norman, A. G., "The Biochemistry of Cellulose, the Polyuronides, Lignin, etc." Oxford, Clarendon Press, 1937. 232 pp.
Norris, F. H., "Paper and Paper Making." London, Oxford Univ. Press, 1952. 353 pp.
Nowak, A., "Chemische Holzverwertung." The 4th ed. of "Die Verwertung des Holzes auf Chemischen Wege," by Josef Bersch. Leipzig, Hartleben, 1932. 303 pp.
Ohl, F., "Die Kunstseiden. Nitrat-, Azetat-, Äther,- Viscose

und Kupferkunstseide." Leipsig, M. Janecke, 1931. 211 pp.
Olmer, L. J., "Le Papier et e les Dérivés de la Cellulose," Paris, Presses Univ. de France, 1943. 128 pp.
Olney, L. A., "Textile Chemistry and Dyeing." 10th ed. Lowell, Mass., Lowell Textile Assoc. 1947.
Öman, E., "Massanalytische Verfahren und deren Anwendung in Zellstofffrabriken." Berlin, Carl Hofmann. Translated from Swedish to German by W. Schmidt. 1928. 119 pp.
Opfermann, E., and Hochberger, E., "Die Bleiche des Zellstoff." III 1 & 2 Berlin, Elsner, 1935–6, 285 and 416 pp.
Opitz, Hans, "Einführung in die Textil-Chemie." Stuttgart, Konradin-Verlag, 1946. 93 pp.
Otcherk, Two books in Russian on the manufacture and use of cellulose. St. Petersburg, 1893. Kiev, 1893.
Ott, Emil, editor. "Cellulose and Cellulose Derivatives." 2nd revised printing. New York, Interscience Publishers, Inc., 1947. 1176 pp. (1st printing, 1943. 1176 pp.).
Ousbey, J. H., "Cellulose Spraying." London, Isaac Pitman and Sons, 1949. 86 pp. 2nd ed. 1952. 92 pp.
Pallás, Miquel, L., "Química de la Cellulosa y de los Materiales Cellulósicos." Alcoy, Justo Llacer, 1950. 440 pp.
Palazzo, F. C., "Cellulose Greggie e Nobili da Matierie Prime Nazionali." Florence, Tip. Mariano Ricci, 1935. 254 pp.
Palazzo, F. C., and Palazzo, F., "Produziore Della Cellulosa da Materie Prime Sicilaine." Palermo, Ires, 1931. 73 pp.
Pannain, E., "La Fibre Tessili e la Loro Lavorazione." Milan, 1914. 298 pp.
Pellinen, H., and Roschier, R. H., "Hiokkeen ja Selluloosan Valmistus." Helsinki, Suomen Paperinsinöörien yhdistys ry, 1952. 604 pp.
Pfeiffer, A., and Krüger, D., "Beiträge zur Oxydation von Cellulose mit Stickstoffdioxyd." Berlin, Verlag Chemi, 1949. 85 pp.
Piest, C., "Die Zellulose, ihre Chemischen Eigenschaften." Stuttgart, Enke, 1910. 157 pp.
Plunguian, Mark, "Cellulose Chemistry." Brooklyn, Chem. Publ. Co., 1943, 97 pp.
Pringsheim, H., "Die Polysaccharide." 2nd ed., Berlin, Springer, 1923. 234 pp.
Pummerer, Rudolf, "Chemische Textilfasern, Filme und Folien." Stuttgart, F. Enke Verlag., 1953. 1464 pp.
Rånby, Bengt G., "Fine Structure and Reactions of Native Cellulose." Stockholm, Grafiska Konstansalten Tryckeri A.B., 1952. 22 pp.
Rath, H., "Lehrbuch der Textilechemie." Berlin, Springer-Verlag. 1952. 627 pp.
Reinthalu, F., "Die Kunstseide und Andere Seidenglänzende Fasern." Berlin, Springer, 1926, 166 pp. English translation by F. M. Rowe, London, Chapman & Hall, 1928. 276 pp.
Renker, M., "Ueber Bestimmungsmethoden der Cellulose." 2 Aufl. Berlin, 1910. 107 pp.
Ristenpart, E., "Chemischen Technologie der Gespinstfasern." Part I. Berlin, M. Krayn, 1923.
Rius Sintes, I., "Fibras Textiles Sinteticas." Barcelona, Bosch Casa Ed., 1953. 352 pp.
Rogovin, Z. A., "Khimiya i Technologiya Iskusstvennykh Volokon." Moscow, State Sci. Tech. Pub. House. Light Ind. 1952. 676 pp.
Routla, O., and Sevon, J., "Über die Ligninstoffe." Helsingfors, 1927.
Sachsse, R., "Die Chemie und Physiologie der Farbstoffe; Kohlenhydrat und Proteinsubstanzen." Leipsig, L. Voss, 1877. 339 pp.
Sandberg, S., "Om Socker och Sprit ur Trä: studier i svenskt näringsliv." Stockholm, 1942.
Schaeffer, A., "Action of Alkali upon Cellulose." Washington, D. C., Hobart Pub. Co., 1947. 94 pp.
Schorger, A. W., "The Chemistry of Cellulose and Wood." New York, McGraw-Hill, 1926. 596 pp.
Schubert, Max, "The Manufacture of Cellulose." New York, A. Geyer, 1899. 220 pp.
Schulz, Walter, "Zur Kenntnis der Cellulosearten . . . nebst Einem Vorwort von Dr. Phil." Carl G. Schwalbe. Berlin, Borntraeger, 1911. 100 pp.
Schulze, F., "Zur Kenntnis des Lignins und seines Vorkommen in Pflanzenkörper." Festschrift zur 400-sten Jubelfeier der Universität Greifswald (1865).
Schwalbe, Carl G., "Die Chemie der Cellulose unter Besonderer Berücksichtigung der Spinnfaser-und Zellstoff-Industrien." 2. Aufl. 1. Hälfte. 1. Abteilung. Berlin, Borntraeger, 1938. 451 pp. (1. Aufl., 1911. 665 pp.).
Schwalbe, Carl G., "Die Chemische Untersuchungen Pflanzlische Rohstoffe und der Daraus Abgescheidenen Zellstoffe." Berlin, 1920. 159 pp.
Schwalbe, Carl G., and Seiber, R., "Die Chemische Betriebskontrolle in der Zellstoff und Papierindustrie und Anderen Zellstoff Verarbeitenden Industrien." 3rd ed. Berlin, Springer, 1931. 547 pp.
Schwarz, R., "Die Technische Herstellung von Zellstoff." Halle, Verlag von Wilhelm Knapp, 1922. 113 pp.
Sedlaczk, Erwin, "Die Mercerisierungsverfahren," Berlin, Julius Springer, 1928. 269 pp.
Sibbern, G. C., "Über den basischen Aufschluss von Fichtenholz in Gegenwart von Alkohol." Zurich, Leemann & Co., 1945. 80 pp.
Sieber, Rudolf, "Die Chemisch-Technischen Untersuchungs-Methoden der Zellstoff-und Papier-Industrie" (1st ed. 1943. 690 pp.). 2. Aufl. Berlin, Springer-Verlag, 1951. 900 pp.
Sieber, Rudolph, "Ueber das Harz der Nadelholzer und die Entharzung von Zellstoff." 2nd ed. Berlin, Carl Hoffmann, 1925. 164 pp.
Sindall, Robert W., "The Manufacture of Paper, and Bibliography of Works Relating to Cellulose and Paper Making." London, Constable, 1908. 275 pp.
Sindall, Robert W., and Bacon, W. N., "The Testing of Wood Pulp." London, M. Singer, 1912. 148 pp.
Siu, Ralph G. H., "Microbial Decomposition of Cellulose." New York, Reinhold, 1951. 583 pp.
Skinkle, J. H., "Textile Testing Physical Chemical and Microscopical." 2nd ed. New York, Chem. Pub. Co., 1949. 365 pp.
Smith, LeRoy H., "German Synthetic Fiber Manufacture." New York, Textile Research Inst., 1946. 1050 pp.
Soletchnik, N. J., "The Hydrolysis of Wood" (in Russian). Moscow, 1933. 152 pp
Stamm, Alfred J., and Harris, Elwin E., "Chemical Processing of Wood." New York, Chemical Publ. Co., 1953. 595 pp.
Stannate, Vivian, "Cellulose Acetate Plastics," New York, Chem. Publ. Co., 1951. 325 pp.
Stark, Chr., "Die Kollodiumwolle." Berlin, M. Krayn, 1931. 171 pp.
Staudinger, Hermann, "Die Hochmolekularen Organischen Verbindungen: Kautschuk und Cellulose." Berlin, Springer, 1932. 540 pp.
Stephenson, J. Newell, editor. "Pulp and Paper Manufacture" I. Preparation and Treatment of Wood Pulp. New York, McGraw-Hill Book Co., 1950. 1043 pp.
Stirm, K., "Chemische Technologie der Gespinstfasern." Berlin, Borntraeger, 1913. 410 pp.
Sutermeister, Edwin, "Chemistry of Pulp and Papermaking." 3rd ed. New York, Wiley, 1941. 529 pp. (1st ed. 1920. 497 pp. 2nd ed. 1929. 565 pp.).
Süvern, K., "Die Kunstliche Seide." Berlin, Springer, 1926. 1108 pp.
Süvern, K., "Die Künstliche Seide, ihre Herstellung und Verwendung." Berlin, Springer, 1931. 642 pp.
Svenska Pappers—och Cellulosaingeniörsförennigen. "Cellulosa och Papper; en Samling Uppsatser Belysande der Svenska Cellulosa-och Pappers-Industriens Utveckling och Nuvarande Standpunkt." SPCI, 1908–1948. Stockholm, 1948. 460 pp.
Tech. Assoc. Pulp and Paper Ind., "TAPPI Tentative and Official Testing Methods, Recommended Practices, Specifications", New York, with revisions to date.
Thaysen, A. C., and Bunker ,H. J., "The Microbiology of Cellulose, Hemicelluloses, Pectins and Gums." London, Oxford Univ. Press. 1927. 363 pp.
Thenius, G., "Das Holz and Seine Destillations—producte." Vienna and Leipsig, A. Hartleben. 1880. 368 pp.
Timell, Tore, "Studies on Cellulose Reactions." Stockholm, Eselte AB., 1950. 275 pp.
Trendelenburg, R., "Das Holz als Rohstoff: Seine Entstehung, Stoffliche Beschaffenheit und Chemische Verwertung." Berlin, J. F. Lehmans, 1939. 435 pp.
Trotman, S. R., and Trotman, E. R., "Artificial Silks." London, Griffin, 1931. 274 pp.
Trotman, S. R., and Trotman, E. R., "Textile Analysis." 2nd ed. London, Charles Griffin Co., 1948. 303 pp.
Trotman, S. R., and Trotman, E. R., "The Bleaching Dyeing, and Chemical Technology of Textile Fibers." 2nd ed. London Charles Griffin, 1946.
Ulmann, Max, "Azetylzellulose-Folien und-Filme." Halle, W. Knapp, 1932. 146 pp.
Vogel, H., "Die Sulfitzellstoff-Ablauge und ihre Ververtung." Stuttgart, 1939.
Völkel, Ernst, "Kunstseiden-und Zellwollarten." Leipzig, Jänecke, 1937. 74 pp. 4th ed. 1942. 155 pp.
Walland, F., "Einfuhrung in die Quantitativen Textilchemischen Untersuchungen." Vienna, Holder-Pickler,-Temsky. 1930. 206 pp.
Want, Darcy van der, "Cellulose-Natriumhydroxyde-Water." Delft, Naamlooze Vennootschap. W. D. Meinema. 134 pp.
Weltzein, W., and Götze, K., "Chemische und Physikalische Technoligie der Kunstseiden." Leipzig, Akademische Vorlagsgesellschaft, 1930. 521 pp.
West, C. J., "Lignin Plastics and Paper-Base Plastics." Appleton, Wis., Inst. of Paper Chem., 1943. 150 pp.

Westhoff, F., "Zur Kenntnis der Viscose und der Daraus Regenerierten Cellulose." Hildesheim, A. Lox, 1911. 44 pp.
Wheeler, E., "The Manufacture of Artificial Silk." New York, D. Van Nostrand, 1931. 177 pp.
Williams, R. T., editor. "Biological Transformation of Starch and Cellulose." New York, Cambridge Univ. Press, 1953.
Wise, Louis E., editor. "Wood Chemistry." New York, Reinhold Publ. Corp., 1944. 900 pp.
Wise, Louis E., and Jahn, Edwin C., editors. "Wood Chemistry." 2 vols. New York. Reinhold Publ. Corp., 1952. 1343 pp.
Witham, George S., Sr., "Modern Pulp and Paper Making." 2nd ed. New York, Reinhold Publ. Co., 1942. 705 pp.
Witt, O. N., und Lehmann, L., "Chemische Technologie der Gespinstfasern, Ihre Geschicte Gewinnung, Verarbeitung und Veredlung." In Vol. 2 of P. A. Bolley's Handbuch der Chemischen Technology." Braunschweig 1888–1902.
Woodhouse, Thomas, "Artificial Silk; its Manufacture and Uses." London, I. Pitman & Sons, 1927. 137 pp. 2nd ed. 1929. 245 pp.
Worden, Edward C., "Nitrocellulose Industry." New York, Van Nostrand, 1911. 1274 pp.
Worden, Edward C., "Technology of Cellulose Esters." 5 vols. Easton, Pa., Eschenbach Printing Co., 1921. 3709 pp.
Worden, E. C., "Technology of Cellulose Ethers." 5 vols. Millburn, N. J., Worden Laboratory and Library, 1933. 3396 pp.
Wurz, O., "Die Sulfitstoffherstellung und Ihre Nebenerzeugnisse." Garz, 1948.
Yarsley, V. E., "Uber die Herstellung und Physikaleschen Eigenschaften der Cellulose-Acetate." Berlin, Springer, 1926. 46 pp.
Zart, A., "Herstellung und Eigenschaften der Kunstseide und Stapelfaser." Leipsig, Akad. Verlags., 1935. 118 pp.

II. Related Literature Containing Information Bearing on Cellulose

Abderhalden, Emil, "Biochemisches Handlexicon." Berlin, Springer, 1911. Band XIII Berlin, Springer, 1930. 1085 pp.
Alexander, Jerome, "Colloid Chemistry, Theoretical and Applied VI. General Principles and Specific industries; Synthetic Polymers and Plastics." New York, Reinhold, 1946. 1215 pp.
Alfrey, Turner, "Mechanical Behavior of High Polymers." New York, Interscience, 1948. 595 pp.
Ambronn, H., and Frey-Wyssling, A., "Das Polarization Microscop." Leipzig, Akademische Verlag, 1926. 194 pp.
Am. Paper and Pulp Assoc., "The Dictionary of Paper;" Including pulps, boards, paper properties and related papermaking terms, New York, 1940.
Am. Soc. Test. Materials, "ASTM Standards on Paint, Varnish and Related Products." Philadelphia, A.S.T.M., 1952. 800 pp.
Am. Soc. Test. Materials, "ASTM Standards on Wood, Wood Base Materials and Wood Preservatives." Philadelphia, A.S.T.M., 1954. 350 pp.
Armstrong, E. F., and Armstrong, K. F., "The Carbohydrates." London, Longmans, 1934. 252 pp.
Balston, J. N., and Talbot, B. E., comp., "A Guide to Filter Paper and Cellulose Powder Chromatography." Ed. by Tudor S. G. Jones, London, H. Reeve Angel & Co., Ltd., and Maidstone, W. and R. R. Balston Ltd., 1952. 145 pp.
Bawn, C. E. H., "The Chemistry of High Polymers." New York, Interscience, 1948. 249 pp.
Bell, D. J., "Introduction to Carbohydrate Biochemistry." London, Univ. Tutorial Press, 1940. 112 pp.
Block, Richard J., LeStrange, Raymond, and Zweig, Gunter," Paper Chromatography: a Laboratory Manual." New York, Academic Press, 1952. 195 pp.
Bonner, J., "Plant Biochemistry." New York, Academic Press, 1950. 537 pp.
Brown, Harry P., and Panshin, A. J., "Commercial Timbers of the United States, their Structure, Identification, Properties and Uses." New York, McGraw-Hill, 1940. 554 pp.
Brown, Harry P., Panshin, A. J., and Forsaith, C. C., "Textbook of Wood Technology. II. The Physical, Mechanical and Chemical Properties of the Commercial Woods of the United States." New York, McGraw-Hill Book Co., 1952. 783 pp.
Browne, C. A., "Handbook of Sugar Analysis." New York, Wiley, 1912. 787 & 101 pp.
Brunauer, S., "The Absorption of Gases and Vapors." London, 1943.
Burk, R. E., and Grummitt, Oliver, editors. "The Chemistry of Large Molecules." New York, Interscience Publishers, Inc., 1943. 313 pp.
Campbell W. B., "The Cellulose-Water Relationship in Paper Making." Can. Dept. Int., Forest Service Bull. 84, 1933. 52 pp.
Canada, Dept. of the Interior. Forestry Branch, Forest Products Laboratories Division, "Canadian woods, their properties and uses." 2nd ed. Ottawa, Edmond Cloutier, King's Printer, 1951. 367 pp.
de Candolle, A. P. "Pflanzen-Physiologie." German translation by J. Roper, Stuttgart, and Tubingen, J. G. Cota, 1883–5, 2 V.
Egge, R., "Laerboge i Biokemi." 2nd ed. Copenhagen, Nyt. nordisk Forlag, 1930. 440 pp.
Elsner, Horst, "Grundriss der Kohlenhydrat-Chemie." Berlin, P. Parey, 1941. 216 pp.
Flory, Paul J., "Principles of Polymer Chemistry," Ithaca, N. Y., Cornell Univ. Press., 1953. 672 pp.
Frey-Wyssling, A., editor. "Deformation and Flow in Biological Systems." New York, Interscience, 1952. 552 pp.
Frey-Wyssling, A., "Die Stoffausscheidung der Höheren Pflanzen." Berlin, Springer, 1935. 378 pp.
Frey-Wyssling, A., "Submicroscopic Anatomy of Protoplasm and Its Derivatives." 2nd ed., Amsterdam, Houston, Elsevier, 1953. 411 pp.
Frith, E. M., and Tuckett, R. F., "Linear Polymers." London, Longmans, Green, 1951.
Garrett, G. A., "The Mechanical Properties of Wood." New York, John Wiley, 1931. 276 pp.
Gisvold, O., and Rogers, C. H., "The Chemistry of Plant Constituents." Minneapolis, Burgess, 1943. 484 pp.
Gortner, R. A., "Outline of Biochemistry." New York, Wiley, 1929. 793 pp. 2nd ed. 1938. 1017 pp. 3rd ed. 1949. 1078 pp.
Guenther, E., "The Essential Oils." New York, D. Van Nostrand, 1948–52. 6 V.
Haas, P. and Hill, T. G., "Chemistry of Plant Products," vI., New York, Longmans, Green, 1928. 530 pp.
Haworth, W. N., "The Constitution of Sugars." London, Edward Arnold, 1929. 100 pp.
Hermans, J. J., editor. "Flow Properties of Disperse Systems." Amsterdam, North-Holland Publ. Co., 1953. 445 pp.
Heyn, A. N. J., "Fiber Microscopy." New York, Interscience, 1953. 396 pp.
Hill, Rowland, editor. "Fibres from synthetic polymers." Amsterdam, London, Houston, and New York, Elsevier, 1953. 554 pp.
Houwink, R., "Elasticity, Plasticity and Structure of Matter." Cambridge, University Press, 1937. 376 pp.
Houwink, R., "Elastomers and plastomers." Vol. 2. New York, Elsevier Publ. Co., 1949. 515 pp.
Hudson, Claude, S., and Cantor, Sidney M., editors, and Peat, Stanley, and Stacey, Maurice, Assoc. editors. "Advances in Carbohydrate Chemistry." New York, Academic Press, 1951, vol. 6. 442 pp.
Hudson, Claude S., Wolfrom, Melville L., and Cantor, Sidney M., editors, and Peat, Stanley, and Stacey, Maurice, assoc. editors, "Advances in Carbohydrate Chemistry." New York, Academic Press, 1952. vol. 7. 370 pp.
Hunter, Dard, "Papermaking." New York, Alfred Knopf, 1943. 398 pp.
Isenberg, Irving H., "Pulpwoods of United States and Canada." 2nd ed. Appleton, Wis. The Institute of Paper Chemistry, 1951. 185 pp.
Karrer, P., "Polymere Kohlenhydrate." Leipzig, Akademische Verlagsgesellschaft, 1925. 285 pp.
Kausch, O., "Handbuch der Künslichen Plastischen Massen." Berlin, J. F. Lehmans Verlag., 1939. 534 pp.
Kertesz, Z. I., "The Pectic Substances." New York, Interscience Publishers, 1951. 644 pp.
Kind, Walter, "Textilindustrie." Berlin & Leipsig, W. de Gruyter, 1923, 408 pp.
Klein, G., editor. "Handbuch der Pflanzen-Analyse, Zweiter Teil, Organische Stoffe. II. Erste Hälfte und Zweite Hälfte." Wein, Julius Springer, 1932. 1613 pp.
Koehler, A., "The Properties and Uses of Wood." New York, McGraw-Hill, 1924. 354 pp.
Kollman, "Technologie des Holzes und der Holzwerkstoffe. 2. Neubearb. u. erw. Aufl." Berlin; Springer-Verlag, 1951." 1. Band. Anatomie und Pathologie, Chemie, Physik, Elastizität und Festigkeit." 1050 pp.
Leaderman, H., "Physics of High Polymers." Utrecht, Univ. Press, 1951.
Lippman, E. O. von, "Geschichte des Zuckers," 2nd ed., Berlin, Springer, 1929. 824 pp.
Mantel, C. L., "The Water-Soluble gums." New York, Reinhold Publ. Corp., 1947. 279 pp.
Mark, H. F., "Physical Chemistry of High Polymeric Systems." New York, Interscience Publishers, 1940. 345 pp.
Merideth, R., "Mechanical Properties of Textiles." Amsterdam, North-Holland Publ. Co. in preparation.

Meyer, Kurt H., "Natural and Synthetic High polymers," 2nd ed. New York, Interscience Publishers, 1950. 891 pp.
Micheel, F., "Chemie der Zucker und Polysaccharide." Leipzig, Akademische Verlagsgesellschaft, 1939. 339 pp.
Miller, A. R., "The Theory of Solutions of High Polymers." Oxford, Clarendon Press, 1948. 117 pp.
Mohler, H., "Lösungsspektren, mit Spektren der Vitamine, Hormone, des Lignins und der Chemischen Kampstoffe." Jena, Fischer, 1937. 92 pp.
Nägeli, C. von, "Die Stärkekörner. Morphologische Physiologische, Chemisch-Physikalische und Systematisch-Botanische Monographie (Pflanzen-physiologische Untersuchungen Heft 2)." Zurich, F. Schulthess, 1858.
Parnell, E. A., "Life and Labors of John Mercer." London, Longmans Green, 1886.
Percival, E. G. V., "Structural Carbohydrate Chemistry." London, Frederick Muller, Ltd., 1950. 246 pp.
Pigman, W. W., and Goepp, R. M., Jr. "Chemistry of the Carbohydrates." New York, Academic Press, 1948. 748 pp.
Pigman, W. W., and Wolfrom, M. L., editors, and Peat, Stanley, and Stacey, Maurice, Assoc. editors. "Advances in Carbohydrate Chemistry." New York, Academic Press, 1945–1949. 5 vols.
Powers, P. O., "Synthetic Resins and Rubbers." New York, John Wiley, 1943. 296 pp.
Preston, J. M., editor. "Fiber Science," 2nd ed. Manchester, The Textile Inst., 1953. 408 pp.
Pringsheim, Hans, "Die Polysaccharide." 2nd ed. Berlin, Julius Springer, 1923. 234 pp. 3rd ed. 1931. 393 pp.
Pringsheim, Hans, "The Chemistry of the Monosaccharides and of the Polysaccharide." New York, McGraw-Hill, 1932. 413 pp.
Record, S. J., "Identification of the Timbers of Temperate North America." New York, John Wiley, 1934, 196 pp.
Robinson, Howard A., "High-polymer Physics, a symposium, publ. under the auspices of the American Institute of Physics. Brooklyn, Chem. Publ. Co., Remsen Press Div., 1948. 572 pp.
Reiner, M., "Deformation and Flow." London, H. K. Lewis, 1949.
Seegers, W. H., and Sharp, E. A., "Hemostatic agents, with particular reference to thrombin, fibrinogen, and absorbable cellulose." Springfield, Ill., C. C Thomas, 1948. 131 pp.
Sherman, J. V., and Sherman, S. L., "The New Fibers." New York, Van Nostrand, 1946. 531 pp.
Simonds, H. R., Weith, A. J., and Bigelow, M. H., "Handbook of Plastics." New York, Van Nostrand, 2nd ed., 1949. 1511 pp.
Stillwell, Charles W., "Crystal Chemistry." New York, McGraw-Hill Book Co., 1938. 431 pp.
Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge." Oxford, Clarendon Press, 1940.
Tiemann, H. D., "Wood Technology." New York, Pitman, 1942. 316 pp.
U. S. Forest Products Laboratory, "Wood Handbook." Revised ed., U. S. Dept. of Agriculture, 1940.
Vidal, Louis, "L'Analyse Microscopique des Papiers." Grenoble de L'Imprimerie Saint-Bruno, 1939. 147 pp., 72 plates of microphotographs.
Wehmer, C., "Plant Products; Chemical Constituents and Composition of Plants; Raw Materials and Products," (In German) Jena, Fischer, 1911. 937 pp.
Whistler, Roy Lester, and Smart, Charles Louis, "Polysaccharide Chemistry." New York, Academic Press, 1953. 533 pp.
Wiesner, J., "Die Rohstoffe des Pflanzenreichs," 4th ed., Leipzig, Engelmann, 1927. 2 V.
Zsigmondy, R., "Kolloidchemie." 3rd ed. Leipsig, O. Spamer, 1920. 429 pp.

Available Bibliographies in the Cellulose, Pulp, and Paper Fields

JACK WEINER

Bibliographies on the chemistry of cellulose and its derivatives are found mostly in books, periodicals, and reviews in the form of literature cited or bibliographical footnotes, for the most part in the unannotated form. This dearth of annotated bibliographies is due to the vastness of the field, and to the lack of any central organization for the planning and preparation of these bibliographies. Examples of comprehensive reviews of the literature on cellulose and cellulose derivatives are given in the appended general bibliography of this paper. These references contain unannotated bibliographies in the form of footnotes or literature cited.

However, the number of annotated bibliographies which have been prepared in the pulp and paper fields far exceeds the total in the field of cellulose and its derivatives. A selected list of bibliographies and review articles in the former category can also be found in the general bibliography of this paper.

There is, perhaps no greater tribute to the memory of C. J. West than to state that a large part of the available bibliographies on pulp and paper originated from his pen.

As director of the Information Department of Arthur D. Little, Inc., from 1919 to 1921, he prepared bibliographies on "The production of alcohol from sulphite waste liquors," "Bagasse: use for fuel and paper," "Papermaking materials," "Bleaching of paper pulp," "Sizing of paper," and a series on special papers.

From 1921, when he became a staff member of the National Research Council, first as scientific associate and later as director of their Research Information Service, until his appointment as Editor of The Institute of Paper Chemistry, the bibliographies prepared by him included a series on Paper Research Literature, the Bibliography on Pulp and Paper Making for 1900–28, 1928–35, and in yearly volumes from 1931 to 1934, a series of U. S. Patents on Papermaking, and a number of miscellaneous compilations, all of which are listed in the appended classified bibliography.

It wasn't until 1936, when he joined the staff of The Institute of Paper Chemistry as its editor, that the number of his bibliographies on cellulose, pulp, and paper increased tremendously. Of the 182 bibliographies prepared at the Institute since its founding in 1929, Dr. West compiled 120, in 18 of which he was co-author. Twenty-nine of the bibliographies were annotated.

During this period, while serving as chairman of the Committee on Bibliography of the Technical Association of the Pulp and Paper Industry, he prepared the Bibliography of Papermaking in yearly volumes from 1936 through 1952 (the 1952 volume was only partially completed at the time of his death), in addition to the 1936–45 and 1946–50 volumes.

While all this work was being done, Dr. West found time to prepare a monograph series for the Sugar Research Foundation entitled "The utilization of sugar cane bagasse for paper, board, plastics, and chemicals."

He also continued his series on "U. S. Patents on Papermaking," which had its inception around 1920, and has appeared in recent years in *Tappi* magazine.

A classified breakdown of all the bibliographies on cellulose, pulp, and paper prepared by Dr. West shows the following:*

* Sources used for the compilation of the bibliographies will be found in references (1–8).

Classification	*Number*	*Per cent*
Alkaline processes	2	1.2
Beating and refining	3	1.8
Bleaching	5	3.0
Cellulose	11	6.8
Chemical testing	3	1.8
Dyes and dyeing	1	0.6
Filling and loading materials	4	2.4
General	20	11.9
Lignin	1	0.6
Literature of pulp and papermaking	16	9.6
Machinery	24	14.3
Miscellaneous pulping processes	9	5.4
Paper and paper treatments	19	11.3
Paper properties and testing	11	6.8
Papermaking materials	10	6.0
Patents	8	4.8
Pulp properties and pulp testing	1	0.6
Recovery and utilization of waste materials	9	5.4
Sizing	4	2.4
Sulphite processes	5	3.0
Wood	1	0.6

Jack Weiner, Editor, The Institute of Paper Chemistry, Appleton, Wis.

It is interesting to note from this analysis that the largest category of bibliographies is Machinery, with 24 or 14.3% of the total. This classification includes such items as barkers, calender and dandy rolls, digesters, fourdrinier wires, papermaking felts, pumps, rod mills, and suction boxes.

The next largest section, excluding General, which is a catchall, is Paper and Paper Treatments with 19 or 11.3% of the total. This includes special papers, coating of printing papers, moisture content control of paper on the machine, fireproofing agents for paper and board, paper drying, sheet formation on the paper machine, application of synthetic resins in the manufacture of paper and board, and vulcanized fiber.

The number in each classification might be considered to represent the interests of the industry in that particular phase of the subject at the time the bibliographies were prepared.

A CLASSIFIED BIBLIOGRAPHY OF BIBLIOGRAPHIES ON CELLULOSE, PULP, AND PAPER BY C. J. WEST

Alkaline Processes

1. West, C. J., Alkaline processes. 2. Black liquors. Bibliographic Series No. 178. Appleton, Wis., The Institute of Paper Chemistry, 1952. 377 p. Annotated.
2. West, C. J., Recent references on soda process. Bibliographic Series No. 98. Appleton, Wis., The Institute of Paper Chemistry, 1941. 16 p.

Beating and Refining

3. West, C. J., Hydration. Bibliographic Series No. 125. Appleton, Wis., The Institute of Paper Chemistry, 1941. 11 p.
4. West, C. J., Stock preparation. Part 1. Beating. Bibliographic Series No. 181. Appleton, Wis., The Institute of Paper Chemistry, 1953. 261 p. Annotated.
5. West, C. J., Stock preparation. Part 2. Refining. Bibliographic Series No. 182. Appleton, Wis., The Institute of Paper Chemistry, 1953. 179 p. Annotated.

Bleaching

6. West, C. J., Bleaching of kraft pulp. Bibliographic Series No. 42. Appleton, Wis., The Institute of Paper Chemistry, 1938. 5 p.
7. West, C. J., The bleaching of paper pulp. *Paper Trade J. 71*, No. 24: 36, 38, 40, 42, 48 (Dec. 9, 1920).
8. West, C. J., Chlorine bleaching of pulps. Bibliographic Series No. 76. Appleton, Wis., The Institute of Paper Chemistry, 1939. 14 p.
9. West, C. J., and Ayers, L., High density bleaching of pulps. Bibliographic Series No. 131. Appleton, Wis., The Institute of Paper Chemistry, 1942. 10 p.
10. West, C. J., Multiple-stage bleaching. Bibliographic Series No. 138. Appleton, Wis., The Institute of Paper Chemistry, 1942. 19 p.

Cellulose

11. West, C. J., Alpha-cellulose: Preparation and properties. Bibliographic Series No. 37. Appleton, Wis., The Institute of Paper Chemistry, 1938. 16 p.
12. West, C. J., Chemical testing methods. Part I. Viscosity of cellulose. Bibliographic Series No. 179. Appleton, Wis., The Institute of Paper Chemistry, 1952. 85 p. Annotated.
13. West, C. J., Determination of alpha-cellulose. Bibliographic Series No. 38. Appleton, Wis., The Institute of Paper Chemistry, 1938. 6 p.
14. Browning, B. L., and West, C. J., Determination of cellulose. Bibliographic Series No. 121. Appleton, Wis., The Institute of Paper Chemistry, 1941. 13 p.
15. Browning, B. L., and West, C. J., Determination of hemicelluloses. Bibliographic Series No. 105. Appleton, Wis., The Institute of Paper Chemistry, 1941. 16 p.
16. West, C. J., Hemicelluloses. Bibliographic Series No. 104. Appleton, Wis., The Institute of Paper Chemistry, 1941. 17 p.
17. West, C. J., Holocellulose. Bibliographic Series No. 110. Appleton, Wis., The Institute of Paper Chemistry, 1941. 4 p.
18. West, C. J., and Sigvardt, C. M., Hydrocellulose. Bibliographic Series No. 127. Appleton, Wis., The Institute of Paper Chemistry, 1942. 11 p.
19. West, C. J., and Gates, D., Oxycellulose. Bibliographic Series No. 124. Appleton, Wis., The Institute of Paper Chemistry, 1941. 19 p.
20. West, C. J., Recent literature on the determination of cellulose. *Paper Trade J. 72*, No. 17: 50, 52, 54 (April 21, 1921). Annotated.
21. West, C. J., and Tongren, J. C., The viscosity of cellulose and methods for its measurement. Bibliographic Series No. 29. Appleton, Wis., The Institute of Paper Chemistry, 1937. 13 p.

Chemical Testing

22. Browning, B. L., and West, C. J., Analytical methods for wood. 1. General. 2. Minor constituents. Bibliographic Series No. 122. Appleton, Wis., The Institute of Paper Chemistry, 1941. 18 p.
23. Browning, B. L., and West, C. J., Determination of alkoxyl group. Bibliographic Series No. 123. Appleton, Wis., The Institute of Paper Chemistry, 1941. 9 p.
24. West, C. J., Analysis of bleach liquors. Bibliographic Series No. 111. Appleton, Wis., The Institute of Paper Chemistry, 1941. 8 p.

Dyes and Dyeing

25. West, C. J., The dyeing of pulp and paper. *Paper Trade J. 72*, No. 20: 46, 48, 50, 52, 54, 58 (May 12, 1921).

Filling and Loading Materials

26. West, C. J., I. Applications of clay in the paper industry II. Bentonite—some properties and applications. Bibliographic Series No. 148. Appleton, Wis., The Institute of Paper Chemistry, 1943. 22 p.
27. West, C. J., Clay in the paper industry. *Paper Trade J. 72*, No. 23: 52, 54, 56 (June 2, 1921).
28. West, C. J., Fillers and loading materials. Bibliographic Series No. 163. Appleton, Wis., The Institute of Paper Chemistry, 1944. 162 p. Annotated.
29. West, C. J., Fundamental properties of clays. Bibliographic Series No. 49. Appleton, Wis., The Institute of Paper Chemistry, 1938. 17 p.

General

30. West, C. J., and Berolzheimer, D. D., Bibliography of bibliographies on chemistry and chemical technology. *Bull. Natl. Research Council (U. S.)*, No. 50, 308 p., 1925; No. 71, 161 p., 1929; No. 86, 150 p., 1932.
31. West, C. J., Causticizing: The utilization of lime sludge. Bibliographic Series No. 67. Appleton, Wis., The Institute of Paper Chemistry, 1939. 11 p.
32. West, C. J., Circulation in digesters. Bibliographic Series No. 73. Appleton, Wis., The Institute of Paper Chemistry, 1939. 13 p.
33. West, C. J., I. Constant humidity rooms. II. Ventilation of pulp and paper mills. Bibliographic Series No. 137. Appleton, Wis., The Institute of Paper Chemistry, 1942. 15 p.
34. West, C. J., Feed water. Bibliographic Series No. 78. Appleton, Wis., The Institute of Paper Chemistry, 1939. 16 p.
35. West, C. J., Lignin and lignocellulosic plastics. Bibliographic Series No. 166. Appleton, Wis., The Institute of Paper Chemistry, 1946. 95 p. Annotated.
36. West, C. J., Lignin plastics. Bibliographic Series No. 114. Appleton, Wis., The Institute of Paper Chemistry, 1941. 9 p.
37. West, C. J., I. Lignin plastics. II. Paper-base plastics. Bibliographic Series No. 161. Appleton, Wis., The Institute of Paper Chemistry, 1943. 124 p. Annotated.
38. West, C. J., and Hull, C., List of manuscript bibliographies in chemistry and chemical technology. *Reprint and Circ. Ser. Natl. Research Council (U. S.)*, No. 36. 1922. 17 p.
39. West, C. J., Manufacture, chemical and physical properties, methods of testing, etc., of pulp and paper. National Research Council, Washington, D. C. (5000 entries, by author, arranged under principal papermaking subjects. $^1/_2$ complete.) [1922.]
40. West, C. J., Mensuration of pulpwood. Bibliographic Series No. 55. Appleton, Wis., The Institute of Paper Chemistry, 1939. 5 p.
41. West, C. J., Methods of filling digesters with chips. Bibliographic Series No. 57. Appleton, Wis., The Institute of Paper Chemistry, 1939. 8 p.
42. West, C. J., Paper-base plastics. Bibliographic Series No. 167. Appleton, Wis., The Institute of Paper Chemistry, 1946. 102 p. Annotated.
43. West, C. J., Kunz, W. B., and Sears, G. R., Permeability of organic materials to gases. Bibliographic Series No. 169. Appleton, Wis., The Institute of Paper Chemistry, 1948. 292 p. Annotated.

44. West, C. J., Pitch. Bibliographic Series No. 23. Appleton, Wis., The Institute of Paper Chemistry, 1937. 10 p.

45. West, C. J., Process water in papermaking. Bibliographic Series No. 72. Appleton, Wis., The Institute of Paper Chemistry, 1939. 12 p.

46. West, C. J., Rayon pulps. Bibliographic Series No. 129. Appleton, Wis., The Institute of Paper Chemistry, 1942. 14 p.

47. West, C. J., Slime control and prevention. Bibliographic Series No. 170. Appleton, Wis., The Institute of Paper Chemistry, 1949. 76 p.

48. West, C. J., Storage of pulp. Bibliographic Series No. 74. Appleton, Wis., The Institute of Paper Chemistry, 1939. 7 p.

49. West, C. J., White water. Bibliographic Series No. 84. Appleton, Wis., The Institute of Paper Chemistry, 1940. 14 p.

Lignin

50. Browning, B. L., and West, C. J., Determination of lignin. Direct and indirect methods. Bibliographic Series No. 97. Appleton, Wis., The Institute of Paper Chemistry, 1941. 22 p.

Literature of Pulp and Papermaking

51. Herzberg W., Paper research literature. VI. A list of the contributions by the staff of the Königliche Materialsprüfungsamt zu Berlin-Lichterfelde West. Transl. and augmented by C. J. West. *Paper Trade J. 71*, No. 17: 48, 50, 52, 54, 56, 58; No. 18: 52, 54, 56, 58, 60, 62, 64, 66, 68 (Oct. 21, 1920).

52. West, C. J., Bibliography of papermaking, 1920, 1921. *Paper 28*, No. 7: 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 204, 206 (April 20, 1921); *Paper Trade J. 74*, No. 16: 51–4; No. 17: 53–6, 58; No. 18: 60, 62, 64; No. 19: 60, 62, 64; No. 20: 51–3, 57 (April 20, 27, May 4, 11, 18, 1922); *Tech. Assoc. Papers 5*: 96–114 (1922).

53. West, C. J., and Papineau-Couture, A., Bibliography of papermaking. *1922. Paper Trade J. 76*, No. 16: 49–52; No. 17: 53–6; No. 18: 53–6; No. 19: 52–6; No. 20: 48–50; No. 22: 55–8; No. 23: 62–4; No. 25: 54–6; No. 26: 48 (April 19, 26, May 3, 10, 17, 31, June 7, 21, 28, 1923); *Tech. Assoc. Papers 6:* 119–48 (1923). *1923. Paper Trade J. 78*, No. 17: 52–4; No. 18: 49–54; No. 19: 53–6; No. 20: 49–52; No. 21: 45–7; No. 22: 51–2; No. 23: 55–7; No. 24: 45–6; No. 25: 41–3 (April 24, May 1, 8, 15, 22, 29, June 5, 12, 19, 1924); *Tech. Assoc. Papers 7:* 106–32 (1924). *1924. Paper Trade J. 80*, No. 7: 51–4; No. 8: 53–6; No. 9: 51–4; No. 10: 63–6; No. 11: 59–62; No. 12: 55–8; No. 13: 51–4; No. 15: 55–8; No. 16: 54–7 (Feb. 12, 19, 26, March 5, 12, 19, 26, April 9, 16, 1925); *Tech. Assoc. Papers 8*: 110–44 (1925). *1925. Paper Trade J. 82*, No. 10: 53–6; No. 11: 56–60; No. 12: 51–6; No. 13: 62–8; No. 14: 47–51; No. 15: 55–9; No. 16: 41–3 (March 11, 18, 25, April 1, 8, 15, 22, 1926); *Tech. Assoc. Papers 9*: 182–214 (1926). *1926. Paper Trade J. 84*, No. 8: 217–60 (Feb. 24, 1927); *Tech. Assoc. Papers 10*, No. 1: 146–67 (1927). *1927. Paper Trade J. 86*, No. 8: 219–59 (odd pages only)(Feb. 23, 1928); *Tech. Assoc. Papers 11*, No. 1: 146–68 (1928).

54. West, C. J., Bibliography of papermaking. *1928. Paper Trade J. 88*, No. 8: 173–231 (odd pages only)(Feb. 21, 1929); *Tech. Assoc. Papers 12*, No. 1: 147–68 (1929). *1929. Paper Trade J. 90*, No. 8: 197–259 (odd pages only) (Feb. 20, 1930); *Tech. Assoc. Papers 13*, No. 1: 147–81 (May, 1930). *1930. Paper Trade J. 92*, No. 8: 145–85 (odd pages only); No. 9: 40–6; No. 10: 47–54 (Feb. 19, 26, March 5, 1931); *Tech. Assoc. Papers 14*: 392–429 (May, 1931).

55. West, C. J., Bibliography of paper making and United States patents on paper making and related subjects, 1931. New York, Technical Association of the Pulp and Paper Industry, 1932. 175 p. *1932.* 175 p. *1933.* 169 p. *1934.* 191 p.

56. West, C. J., Bibliography of pulp and paper making and United States patents on paper making and related subjects. New York, Lockwood Trade Journal Co. *1936.* 285 p. *1937.* 221 p.

57. West, C. J., Pulp and papermaking. Bibliography and United States patents. New York. Technical Association of the Pulp and Paper Industry. *1938.* 248 p. *1939.* 252 p. *1940.* 250 p. *1941.* 204 p.

58. West, C. J., Pulp and paper manufacture. Bibliography and United States patents. New York, Technical Association of the Pulp and Paper Industry. *1942.* 222 p. *1943.* 223 p. *1944.* 221 p. *1946.* 274 p. *1947.* 232 p. *1948.* 262 p. *1949.* 283 p. *1951.* 420 p. *1952.* 456 p.

59. West, C. J., Bibliography of pulp and paper making, 1900–1928. New York, Lockwood Trade Journal Co., 1929. 982 p. Classified.

60. West, C. J., Bibliography of pulp and paper making, 1928–1935. New York, Lockwood Trade Journal Co., 1936. 803 p. Classified.

61. West, C. J., Bibliography of pulp and paper manufacture, 1936–1945. New York, Technical Association of the Pulp and Paper Industry, 1947. 1053 p. Classified.

62. West, C. J., Pulp and paper manufacture. Bibliography, 1946–1950. New York, Technical Association of the Pulp and Paper Industry, 1951. 752 p. Classified.

63. West, C. J., Paper research literature (VIII). Biography and bibliography of the works of C. F. Cross. *World's Paper Trade Rev. 75*, No. 4: 338, 340, 342 (Jan. 28, 1921); *Paper Trade J. 73*, No. 3: 46, 48, 50 (July 21, 1921).

64. West, C. J., Paper research literature. I. List of contributions by members of the Forest Products Laboratory on pulp and paper, 1910–1928. *Paper Trade J. 89*, No. 1: 56–62 (July 4, 1929).

65. West, C. J., Paper research literature. I. Revised. A list of the contributions of the members of the Forest Products Laboratory on pulp and paper. *Paper Trade J. 77*, No. 7: 46–50 (Aug. 16, 1923).

66. West, C. J., and Scribner, B. W., Paper research literature (VII). Revised. A list of contributions by members of the U. S. Bureau of Standards, 1910 to Dec. 31, 1924. *Paper Trade J. 80*, No. 21: 46–52 (May 21, 1925). First supplement, *Paper Trade J. 82*, No. 20; 49 (May 20, 1926). Second supplement, *Paper Trade J. 84*, No. 23: 45–6 (June 9, 1927). Third supplement, *Paper Trade J. 86*, No. 17: 51–2 (April 26, 1928). Fourth supplement, Paper *Trade J. 88*, No. 16: 57 (April 18, 1929).

Machinery

67. West, C. J., Barkers and barking of pulpwood. Bibliographic Series No. 79. Appleton, Wis., The Institute of Paper Chemistry, 1940. 25 p.

68. West, C. J., and Bublitz, W., Bearings in the pulp and paper industry. Bibliographic Series No. 150. Appleton, Wis., The Institute of Paper Chemistry, 1943. 12 p.

69. West, C. J., Burners for sulphur and pyrites. Bibliographic Series No. 88. Appleton, Wis., The Institute of Paper Chemistry, 1940. 11 p.

70. West, C. J., Calender rolls. Bibliographic Series No. 106. Appleton, Wis., The Institute of Paper Chemistry, 1941. 15 p.

71. West, C. J., Dandy rolls. Bibliographic Series No. 77. Appleton, Wis., The Institute of Paper Chemistry, 1939. 7 p.

72. West, C. J., Digesters—constructional materials and linings. Bibliographic Series No. 80. Appleton, Wis., The Institute of Paper Chemistry, 1940. 14 p.

73. West, C. J., Doctors. Bibliographic Series No. 107. Appleton, Wis., The Institute of Paper Chemistry, 1941. 6 p.

74. West, C. J., Electricity in pulp and paper mills. A reading list. *Paper Trade J. 76*, No. 8: 50–3 (Feb. 22, 1923).

75. West, C. J., and Gates, D., Fourdrinier wires. Bibliographic Series No. 115–120. Appleton, Wis., The Institute of Paper Chemistry, 1941. 137 p. Annotated.

76. West, C. J., Jordans and other refiners. Bibliographic Series No. 87. Appleton, Wis., The Institute of Paper Chemistry, 1940. 22 p.

77. West, C. J., Lubrication in the pulp and paper industry. Bibliographic Series No. 149. Appleton, Wis., The Institute of Paper Chemistry, 1943. 14 p.

78. West, C. J., Papermaking felts, with a section on the installation and operation of papermaking felts. Bibliographic Series No. 91–96. Appleton, Wis., The Institute of Paper Chemistry, 1941. 138 p. Annotated.

79. West, C. J., Press rolls. Bibliographic Series No. 70. Appleton, Wis. The Institute of Paper Chemistry, 1939. 11 p.

80. West, C. J., Pulpstones. Natural and artificial. Bibliographic Series No. 81. Appleton, Wis., The Institute of Paper Chemistry, 1940. 12 p.

81. West, C. J., and Gray, J. L., Pumps in the pulp and paper industry. Bibliographic Series No. 132. Appleton, Wis., The Institute of Paper Chemistry, 1942. 10 p.

82. West, C. J., Recent references on consistency regulators. Bibliographic Series No. 53. Appleton, Wis., The Institute of Paper Chemistry, 1938. 10 p.

83. West, C. J., Save-alls. Bibliographic Series No. 54. Appleton, Wis., The Institute of Paper Chemistry, 1938. 18 p.

84. West, C. J., Screens. Bibliographic Series No. 108. Appleton, Wis., The Institute of Paper Chemistry, 1941. 31 p.

85. West, C. J., Shake and shaking mechanism. Bibliographic Series No. 101. Appleton, Wis., The Institute of Paper Chemistry, 1941. 7 p.

86. West, C. J., Slice. Bibliographic Series No. 100. Appleton, Wis., The Institute of Paper Chemistry, 1941. 13 p.

87. West, C. J., Some applications of the rod mill in the pulp and paper industry. Bibliographic Series No. 58. Appleton, Wis., The Institute of Paper Chemistry, 1939. 6 p.

88. West, C. J., I. Suction boxes. II. Suction box covers. Bibliographic Series No. 65. Appleton, Wis., The Institute of Paper Chemistry, 1939. 14 p.

89. West, C. J., Suction rolls. Bibliographic Series No. 66. Appleton, Wis., The Institute of Paper Chemistry, 1939. 11 p.

90. West, C. J., White water—savealls. Bibliographic Series No. 180. Appleton, Wis., The Institute of Paper Chemistry, 1952. 149 p. Annotated.

Miscellaneous Pulping Processes

91. West, C. J., Chlorine in the manufacture of paper pulp. *Paper Trade J. 79*, No. 12: 43–4 (Oct. 2, 1924).

92. West, C. J., The chlorine process of pulping. Bibliographic Series No. 32. Appleton, Wis., The Institute of Paper Chemistry, 1937. 9 p.

93. West, C. J., Nitric acid pulping. Bibliographic Series No. 46, Appleton, Wis., The Institute of Paper Chemistry, 1938. 6 p.

94. West, C. J., Pulping processes. Part I. Nitric acid process. Bibliographic Series No. 172. Appleton, Wis., The Institute of Paper Chemistry, 1949. 61 p. Annotated.

95. West, C. J., Pulping processes. Part II. Chlorine process. Bibliographic Series No. 173. Appleton, Wis., The Institute of Paper Chemistry, 1950. 74 p. Annotated.

96. West, C. J., Pulping processes. Part IV. Semichemical processes. Bibliographic Series No. 175. Appleton, Wis., The Institute of Paper Chemistry, 1950. 145 p. Annotated.

97. West, C. J., Pulpwood decay and pulping of decayed wood. Bibliographic Series No. 61. Appleton, Wis., The Institute of Paper Chemistry, 1939. 7 p.

98. West, C. J., Recent literature on soda and sulphate pulps. *Paper Trade J. 73*, No. 16: 46, 48, 50, 52; No. 17: 42, 44, 46 (Oct. 20, 27, 1921).

99. West, C. J., The use of alcohols, phenols, and certain other organic compounds in the pulping process. Bibliographic Series No. 50. Appleton, Wis., The Institute of Paper Chemistry, 1938. 7 p.

Paper and Paper Treatments

100. West, C. J., Applications of rubber latex to special papers (excluding its use as an adhesive). Bibliographic Series No. 52. Appleton, Wis., The Institute of Paper Chemistry, 1938. 21 p.

101. West, C. J., Blotting paper. *Paper Trade J. 71*, No. 22: 48, 50, 52 (Nov. 25, 1920).

102. West, C. J., The coating of printing papers. Bibliographic Series No. 162. Appleton, Wis., The Institute of Paper Chemistry, 1944. 153 p. Annotated.

103. West, C. J., Control of the moisture content of paper on the machine. Bibliographic Series No. 102. Appleton, Wis., The Institute of Paper Chemistry, 1941. 10 p.

104. West, C. J., Filter paper; a reading list. *Paper Trade J. 71*, No. 15: 34, 36, 38, 40 (Oct. 7, 1920).

105. West, C. J., Fireproofing agents for paper and board. Bibliographic Series No. 113. Appleton, Wis., The Institute of Paper Chemistry, 1941. 27 p. Annotated.

106. West, C. J., Paper drying—theory and mechanism. Bibliographic Series No. 126. Appleton, Wis., The Institute of Paper Chemistry, 1941. 9 p.

107. West, C. J., Proofing of paper (waterproofing, watervaporproofing, greaseproofing). Appleton, Wis., The Institute of Paper Chemistry, 1943. 694 p.

108. West, C. J., Reading list on paper yarns and textiles. *Paper Trade J.* 72, No. 22: 42, 44, 46, 48 (May 26, 1921).

109. West, C. J., Rubber latex in papermaking. *Paper Trade J. 79*, No. 7: 41–2 (Aug. 16, 1924).

110. West, C. J., Sheet formation on the paper machine. Bibliographic Series No. 99. Appleton, Wis., The Institute of Paper Chemistry, 1941. 9 p.

111. West, C. J., Some applications of artificial (synthetic) resins in the manufacture of paper and board. Bibliographic Series No. 60. Appleton, Wis., The Institute of Paper Chemistry, 1939. 24 p.

112. West, C. J., Some applications of cellulose derivatives to paper. Bibliographic Series No. 71. Appleton, Wis., The Institute of Paper Chemistry. 1939. 20 p. Annotated.

113. West, C. J., Some applications of starch in the coating and sizing of paper. Bibliographic Series No. 112. Appleton. Wis., The Institute of Paper Chemistry, 1941. 16 p.

114. West, C. J., Some uses of sodium silicate in the paper and board industry. Bibliographic Series No. 103. Appleton, Wis., The Institute of Paper Chemistry, 1941. 22 p.

115. West, C. J., Special papers. III. Cigarette paper. *Paper Trade J. 72*, No. 25: 44 (June 16, 1921).

116. West, C. J., Uses of glycerol in papermaking. Bibliographic Series No. 64. Appleton, Wis., The Institute of Paper Chemistry, 1939. 11 p. Annotated.

117. West, C. J., Vacuum drying of paper. Bibliographic Series No. 68. Appleton, Wis., The Institute of Paper Chemistry, 1939. 5 p.

118. West, C. J., Vulcanized fiber, Bibliographic Series No. 59. Appleton, Wis., The Institute of Paper Chemistry, 1939. 13 p.

Paper Properties and Testing

119. West, C. J., A bibliography of paper testing. Part II. A. Structural properties. B. Surface properties. Bibliographic Series No. 154-156. Appleton, Wis., The Institute of Paper Chemistry, 1943. 96 p. Annotated.

120. West, C. J., A bibliography of paper testing. Part III. Optical properties. Bibliographic Series No. 157–159. Appleton, Wis., The Institute of Paper Chemistry, 1943. 109 p. Annotated.

121. Kauppi, T. A., and West, C. J., The color of paper and its measurement. Bibliographic Series No. 30. Appleton, Wis., The Institute of Paper Chemistry, 1937. 13 p.

122. West, C. J., Determination of the size resistance of paper. Bibliographic Series No. 130. Appleton, Wis., The Institute of Paper Chemistry, 1942. 13 p.

123. West, C. J., Determination of water (moisture) in wood, pulp and paper, and textiles, Bibliographic Series No. 160. Appleton, Wis., The Institute of Paper Chemistry, 1943. 71 p. Annotated.

124. West, C. J., Paper and its relation to printing. Bibliographic Series No. 164. Appleton, Wis., The Institute of Paper Chemistry, 1944. 157 p. Annotated.

125. West, C. J., Paper testing—strength properties. Bibliographic Series No. 139–144. Appleton, Wis., The Institute of Paper Chemistry, 1942. 162 p. Annotated.

126. West, C. J., Testing methods for boards and containers. Bibliographic Series No. 85. Appleton, Wis., The Institute of Paper Chemistry, 1940. 10 p.

127. West, C. J., Wet strength of paper. Bibliographic Series No. 83. Appleton, Wis., The Institute of Paper Chemistry, 1940. 9 p. Annotated.

128. West, C. J., Wet strength of paper. Bibliographic Series No. 147. Appleton, Wis., The Institute of Paper Chemistry, 1943. 16 p. Annotated.

129. West, C. J., Wet strength of paper. Bibliographic Series No. 168. Appleton, Wis., The Institute of Paper Chemistry, 1947. 65 p. Annotated.

Papermaking Materials

130. West, C. J., Bagasse. Use for fuel and paper. Arthur D. Little, Inc., Cambridge, Mass. [1922]. 32 references.

131. West, C. J., Papermaking materials. *Paper Trade J. 71*, No. 25: 44, 46, 48, 50, 52, 54, 62; No. 26: 54, 56, 58, 60, 62 (Dec. 16, 23, 1920); *72*, No. 1: 30, 32, 34, 36, 38 (Dec. 30, 1920); No. 2: 46, 48, 50, 52, 54; No. 3: 30, 32, 34, 36, 38, 40; No. 4: 34, 36, 38, 40, 42, 44; No. 5: 60, 62, 64, 66, 68 (Jan. 6, 13, 20, 27, 1921); No. 6: 58, 60, 62, 64, 66, 68; No. 7: 64, 66, 68, 70, 72; No. 8: 48, 52, 54, 56, 58, 60; No. 9: 54, 56, 58, 60, 62 (Feb. 3, 10, 17, 24, 1921); No. 10: 48, 50, 52, 54, 56 (March 3, 1921). Reprinted as Bibliographic Series No. 6. Arthur D. Little, Inc., Cambridge, Mass., 1921. 170 p.

132. West, C. J., Papermaking properties of flax and hemp. Bibliographic Series No. 62. Appleton, Wis., The Institute of Paper Chemistry, 1939. 14 p.

133. West, C. J., Papermaking materials. Part I. Cereal straws. Bibliographic Series No. 171. Appleton, Wis., The Institute of Paper Chemistry, 1949. 229 p. Annotated.

134. West, C. J., Papermaking materials. Part II. Bast fibers. Bibliographic Series No. 176. Appleton, Wis., The Institute of Paper Chemistry, 1950. 74 p. Annotated.

135. West, C. J., The pulping of cornstalks and products therefrom. Bibliographic Series No. 51. Appleton, Wis., The Institute of Paper Chemistry, 1938. 14 p.

136. West, C. J., Reading list on papermaking materials. 2d ed. New York, Lockwood Trade Journal Co., 1928. 239 p. [Compilation of references published in *Paper Trade J.*]

137. West, C. J., Utilization of bagasse in the manufacture of paper and boards. Bibliographic Series No. 56. Appleton, Wis., The Institute of Paper Chemistry, 1939. 18 p.

138. West, C. J., The utilization of sugar cane bagasse for paper, board, plastics, and chemicals. New York, Sugar Research Foundation, 1946. 146 p. Supplement, 1949. 20 p. Annotated.

139. West, C. J., The utilization of sugar cane bagasse for paper, board, plastics, and chemicals. 2d ed. Technological Rept. Series No. 8. New York, Sugar Research Foundation, Inc., 1952. 202 p.

Patents

140. West, C. J., U. S. papermaking patents for 1920. *Paper 27*, No. 20: 19–21; No. 21: 25–7 (Jan. 19, 26, 1921).

141. West, C. J., United States patents on papermaking. *1935. Paper Trade J. 100*, No. 15: 33–5; *101*, No. 3: 31–3; No. 17: 39–41 (April 11, July 18, Oct. 24, 1935); *102*, No. 5: 31–3 (Jan. 30, 1936); Bibliography of pulp and paper making, 1936: 131–268. *1936. Paper Trade J. 102*, No. 16: 33–5; *103*, No. 2: 26–8; No. 16: 35–7 (April 16, July 9, Oct. 15, 1936); *104*, No. 3: 35–7 (Jan. 21, 1937); Bibliography of pulp and paper making, 1936: 131–268. *1937. Paper Trade J. 104*, No. 17: 31–4; *105*, No. 3: 31–4; No. 17: 39–41 (April 29, July 15, Oct. 14, 1937); *106*, No. 2: 48–50 (Jan. 13, 1938); Bibliography of pulp and

papermaking, 1937: 139–208. *1938. Paper Trade J. 106,* No. 16: 35–8; *107,* No. 2: 31–4; No. 18: 53–5 (April 24, July 14, Nov. 3, 1938); *108,* No. 2: 30–3(Jan. 12, 1939); Bibliography of pulp and papermaking, 1938: 152 227. *1939. Paper Trade J. 108,* No. 15: 39–42; *109,* No. 5: 31–4; No. 17: 35–8 (April 13, Aug. 3, Oct. 26, 1939); *110,* No. 5: 27–30 (Feb. 1, 1940); Bibliography of pulp and papermaking, 1939: 154–232. *1940. Paper Trade J. 110,* No. 17: 25–8; *111,* No. 4: 25–8; No. 17: 33–6 (April 25, July 25, Oct. 24, 1940); *112,* No. 6: 29–33 (Feb. 6, 1941); Bibliography of pulp and papermaking, 1940: 145–230. *1941. Paper Trade J. 112,* No. 17: 31–4; *113,* No. 5: 27–30; No. 18: 34–6 (April 24, July 31, Oct. 30, 1941); *114,* No. 6: 31–3 (Feb. 5, 1942); Bibliography of pulp and papermaking 1941: 119–86. *1942. Paper Trade J. 114,* No. 25: 29–32; *115,* No. 4: 27–30; No. 17: 31–4 (June 18, July 23, Oct. 22, 1942); *116,* No. 5: 25–8 (Feb. 4, 1943); Bibliography of pulp and paper manufacture, 1942: 122–203. *1943. Paper Trade J. 116,* No. 17: 33–6; *117,* No. 5: 23–6; No. 18: 33–5 (April 29, July 29, Oct. 28, 1943); *118,* No. 3: 33–5 (Jan. 20, 1944); Bibliography of pulp and paper manufacture, 1943: 122–203. *1944. Paper Trade J. 118,* No. 24: 29–32; *119,* No. 4: 25–8; No. 22: 29–32 (June 15, July 27, Nov. 30, 1944); *120,* No. 5: 31–3 (Feb. 8, 1945); Bibliography of pulp and paper manufacture, 1944: 126–203. *1945. Paper Trade J. 120,* No. 18: 33–5; *121,* No. 5: 36–8 (May 3, Aug. 2, 1945); *122,* No. 3: 49–52 (Jan. 17, 1946).

142. West, C. J., U. S. patents on papermaking, 1926. *Tech. Assoc. Papers 10,* No. 1: 168–70 (1927); *Paper Trade J. 84,* No. 17: 56–8 (April 28, 1927).

143. West, C. J., U. S. patents on papermaking, 1927. *Paper Trade J. 84,* No. 19: 47–8; No. 23: 47 (May 12, June 9, 1927); *85,* No. 3: 54; No. 8: 55; No. 25: 45 (July 21, Aug. 25, Dec. 22, 1927); *86,* No. 2: 56; No. 4: 51 (Jan. 12, 26, 1928); *Pulp Paper Mag. Can. 26,* No. 2: 48–9 (Jan. 12, 1928).

144. West, C. J., United States patents on paper making. *1927. Tech. Assoc. Papers 11,* No. 1: 280–4 (June, 1928). *1928. Paper Trade J. 86,* No. 18: 68; 87, No. 5: 58–9; No. 16: 38–9; *88,* No. 6: 53–4 (May 3, Aug. 2, Oct. 18, 1928; Feb. 7, 1929); *Tech. Assoc. Papers 12,* No. 1: 191–5 (May, 1929). *1929. Paper Trade J. 88,* No. 16: 61–2; *89,* No. 5: 54–6; No. 17: 53–4; *90,* No. 6: 74–5 (April 18, Aug. 1, Oct. 24, 1929; Feb. 6, 1930); *Tech. Assoc. Papers 13,* No. 1: 292–9 (May, 1930). *1930. Paper Trade J. 90,* No. 19: 55–6: *91,* No. 4: 54–6; No. 17: 41–2; *92,* No. 6: 61–2 (May 8, July 27, Oct. 23, 1930; Feb. 5, 1931); *Tech. Assoc. Papers 14,* No. 1: 430–7 (May, 1931). *1931. Paper Trade J. 92,* No. 22: 36–8; *93,* No. 6: 43–5; No. 17: 35–7; *94,* No. 8: 40–2 (May 28, Aug. 6, Oct. 22, 1931; Feb. 25, 1932); also in his Bibliography of paper making and United States patents, 1931. p. 99–164. *1932. Paper Trade J. 94,* No. 21: 32–4; *95,* No. 5: 34–7; No. 15: 40–2; *96,* No. 6: 36–8 (May 26, Aug. 4, Oct. 13, 1932; Feb. 9, 1933); also in his Bibliography of paper making and United States patents, 1932, p. 92–164. *1933. Paper Trade J. 96,* No. 16: 25–7; *97,* No. 5: 35–7; No. 22: 35–7; *98,* No. 2: 33–6 (April 20, Aug. 3, Nov. 30, 1933; Jan. 11, 1934); also in his Bibliography of paper making and United States patents, 1933, p. 97–157. *1934. Paper Trade J. 98,* No. 18:37–40; *99,* No. 3: 31–4; No. 18: 38–40; *100,* No. 2: 33–5 (May 3, July 19, Nov. 1, 1934; Jan. 10, 1935); also in his Bibliography of paper making and United States patents, 1934, p. 109–178. *1935. Paper Trade J. 100,* No. 15: 33–5; *101,* No. 3: 31–3; No. 17: 39–41 (April 11, July 18, Oct. 24, 1935).

145. West, C. J., United States patents on papermaking. *1946. Paper Trade J. 122,* No. 19: 44–6; *123,* No. 5: 42–4; No. 20: 57–8 (May 9, Aug. 1, Nov. 14, 1946); *124,* No. 5: 50–2 (Jan. 30, 1947); Pulp and Paper Manufacture, Bibliography, 1946: 138–248. *1947. Paper Trade J. 124,* No. 19: 45–6; *125,* No. 3: 36, 38, 40; No. 17: 56–9 (May 8, July 17, Oct. 23, 1947); *126,* No. 6: 60–2 (Feb. 5, 1948); Pulp and Paper Manufacture, Bibliography, 1947: 156–210. *1948. Paper Trade J. 126,* No. 17: 59–60; *127,* No. 6: 55–7 (April 22, Aug. 5, 1948); *Tappi 32,* No. 2: 37–8A, 40A, 42A; No. 4: 65–70A (Feb., April, 1949); Pulp and Paper Manufacture, Bibliography, 1948: 181–238. 1949. *Tappi 32* No. 7: 45–6A, 48A, 50A, 52A; No. 11:55–6A, 58A, 60A, 62A (July, Nov., 1949); *33,* No. 5: 85–91A; No. 6: 85–90A (May, June, 1950); Pulp and Paper Manufacture, Bibliography, 1949: 167–258. *1950. Tappi 33,* No. 10: 90–8A; No. 12:109–13A (Oct., Dec., 1950); *34,* No. 5:129–34A (May, 1951). *1951. Tappi 34,* No. 8: 121–5A (Aug., 1951); *35,* No. 1: 140–5A (Jan., 1951); No. 2: 121–6A, 126–32A (Feb., 1952); Pulp and Paper Manufacture, Bibliography, 1950–51: 187–358. *1952. Tappi 35,* No. 6: 162–7A (June, 1952); No. 9: 154–61A (Sept., 1952); No. 12: 135–41A (Dec., 1952); *36,* No. 5: 150–5A (May, 1953); Pulp and Paper Manufacture, Bibliography, 1952: 231–398.

146. West, C. J., Waste liquors and gases of the paper industry. A survey of recent domestic and foreign patent literature on the utilization of waste liquors and waste gases of the pulp industry, 1925–1930. *Paper Trade J. 92,* No. 3: 48–56; No. 4: 50–6; No. 5: 46–51 (Jan. 15, 22, 29, 1931).

147. West, C. J., Waste liquors and gases of the paper industry. A survey of recent domestic and foreign patent literature on the utilization of waste liquors and waste gases of the pulp industry, 1931–1935. *Tech. Assoc. Papers 19*: 480–510 (June, 1936); *Paper Trade J. 101,* No. 22: 43–8; No. 24: 37–40; No. 25: 46–9; No. 26: 35–8 (Nov. 28, Dec. 12, 19, 26, 1935); *102,* No. 1: 39–44; No. 2: 42–4; No. 3: 31–5 (Jan. 2, 9, 16, 1936).

Pulp Properties and Pulp Testing

148. West, C. J., The screen classification of pulps. Bibliographic Series No. 86. Appleton, Wis., The Institute of Paper Chemistry, 1940. 4 p.

Recovery and Utilization of Waste Materials

149. West, C. J., Black liquor as a pulping agent. Bibliographic Series No. 136. Appleton, Wis., The Institute of Paper Chemistry, 1942. 9 p.

150. West, C. J., and Ratliff, F. T., Black liquor—heat and chemical recovery. Bibliographic Series No. 128. Appleton, Wis., The Institute of Paper Chemistry, 1942. 24 p.

151. West, C. J., and Luey, A. T., Deinking of paper. Bibliographic Series No. 31. Appleton, Wis., The Institute of Paper Chemistry, 1938. 20 p.

152. West, C. J., Deinking of paper. Bibliographic Series No. 151–153. Appleton, Wis., The Institute of Paper Chemistry, 1943. 86 p. Annotated.

153. West, C. J., Evaporation of black liquors. Bibliographic Series No. 75. Appleton, Wis., The Institute of Paper Chemistry, 1939. 12 p.

154. West, C. J., Production of alcohol from sulphite waste liquors. Arthur D. Little, Inc., Bibliographic Series No. 2. *Paper 25,* No. 13: 19 (Dec. 3, 1919).

155. West, C. J., Tall oil, talloel or liquid rosin. A by-product of the alkaline process. Bibliographic Series No. 43. Appleton, Wis., The Institute of Paper Chemistry, 1938. 14 p.

156. West, C. J., Tall oil, talloel, or liquid rosin. A by-product of the alkaline process. Bibliographic Series No. 133–135 (revision of No. 43). Appleton, Wis., The Institute of Paper Chemistry, 1942. 84 p. Annotated.

157. West, C. J., and Csellak, W. R., Waste wood and barking waste as fuel. Bibliographic Series No. 146. Appleton, Wis., The Institute of Paper Chemistry, 1943. 13 p.

Sizing

158. West, C. J., Sizing of paper. Bibliographic Series No. 165. Appleton, Wis., The Institute of Paper Chemistry, 1948. 527 p. Annotated.

159. West, C. J., The sizing of paper. *Paper Trade J. 71,* 20: 50, 52, 54, 56; No. 21: 110, 112, 114, 116 (Nov. 11, 18, 1920).

160. West, C. J., Sizing processes. 1. Bennett. 2. Bewoid. 3. Delthirna. 4. Gillet. Bibliographic Series No. 63. Appleton, Wis., The Institute of Paper Chemistry, 1939. 10 p.

161. West, C. J., Some uses of montan wax in paper making. Bibliographic Series No. 69. Appleton, Wis., The Institute of Paper Chemistry, 1939. 6 p.

Sulphite Processes

162. West, C. J., and Privette, H. J., Alkalies in sulphite pulping including recovery of waste liquors. I. Sodium base. II. Ammonia base. Bibliographic Series No. 145. Appleton, Wis., The Institute of Paper Chemistry, 1943. 28 p.

163. West, C. J., Analysis of burner gases and sulphite cooking liquors. Bibliographic Series No. 90. Appleton, Wis., The Institute of Paper Chemistry, 1940. 10 p.

164. West, C. J., Mechanism of the sulphite process. Bibliographic Series No. 82. Appleton, Wis., The Institute of Paper Chemistry, 1940. 8 p.

165. West, C. J., Pulping processes. Part III. Ammonia, magnesium, and sodium bases for sulfite pulping. Bibliographic Series No. 174. Appleton, Wis., The Institute of Paper Chemistry, 1950. 97 p. Annotated.

166. West, C. J., Some references on the preparation of sulphite cooking acid. Bibliographic Series No. 89. Appleton, Wis., The Institute of Paper Chemistry, 1940. 15 p.

Wood

167. West, C. J. Western woods—economics, supplies, pulping, etc. Bibliographic Series No. 109. Appleton, Wis., The Institute of Paper Chemistry, 1941. 16 p.

GENERAL BIBLIOGRAPHY OF BIBLIOGRAPHIES ON CELLULOSE, PULP, AND PAPER

1. Ahern, G. P., and Newton, H. K., A bibliography of the woods of the world. N. Y., Am. Soc. Mech. Eng., 1928. 77 p. 1530 references.

2. Ainslie, R. A., Pulp and paper. *Repts. Progr. Appl. Chem. 24:* 180–97 (1939). 124 references.

3. Amstutz, E. D., Bibliography of lignin determination. *Bull. Inst. Paper Chem. 2,* No. 3: 143–9 (Nov., 1931). 47 references.

4. Anderson, E., and Sands, L., A discussion of methods of value in research on plant polyuronides. *Advances in Carbohydrate Chem. 1:* 329–44 (1945). 108 references.

5. Appling, J. W., Survey of the literature on the microbiology of pulp and paper. New York, American Paper and Pulp Assoc., 1940. 30 p. 298 references. First Supplement. 1940–1944. 1945. 51 p. 204 references.

6. Aronovsky, S. I., Reid, J. David, Dryden, E. C., Whittemore, E. R., and Lynch, D. F. J., Pulping with nitric acid. A review. *Paper Ind. 21,* No. 1: 41–8; No. 2: 151–5; No. 3: 335–43 (April, May, June, 1939); *Bull. Inst. Paper Chem. 9:* 507; *Brit. Chem. Physiol. Abstr.* 1939B: 925. 170 references.

7. Auszüge aus der Literatur des Zellstoff und Papier-Chemie. Verein der Zellstoff- und Papier-Chemiker und -Ingénieure. With author and subject indexes. 1909–1939. Continued as Auszüge aus der Literatur der Zellstoff- und Papiererzeugung und Celluloseverarbeitung. 1950–.

8. Babbitt, J. D., Absorption of water vapour by cellulose. *Can. J. Research 20,* Section A, No. 9: 143–72 (Sept., 1942); *Bull. Inst. Paper Chem. 13:* 48; *Tech. Bull. Tech. Sect., British Paper and Board Makers' Assoc. 19:* 34. 23 references.

9. Badger, W. L., and Lindsay, R. A., Evaporation. *Ind. Eng. Chem. 39,* No. 1: 22, 37 (Jan., 1947); *Bull. Inst. Paper Chem. 17:* 288. 29 references. *40,* No. 1: 22–5 (Jan., 1948); *Bull. Inst. Paper Chem. 18:* 365. 46 references. *41,* No. 1: 32–4 (Jan., 1949); *Bull. Inst. Paper Chem. 19:* 392. 44 references. *42,* No. 1: 45–7 (Jan., 1950); *Bull. Inst. Paper Chem. 20:* 394. 36 references. *43,* No. 1: 75–8 (Jan., 1951); *Bull. Inst. Paper Chem. 21:* 393. 48 references. *44,* No. 1: 50–3 (Jan., 1952); *Bull. Inst. Paper Chem. 22:* 403. 58 references. *45,* No. 1: 55–8 (Jan., 1953); *Bull. Inst. Paper Chem. 23:* 403. 61 references.

10. Bailey, A. J., Lignin in Douglas-fir. *Paper Ind. 16,* No. 7: 480–3 (Oct., 1934); *Chem. Abstr. 29*: 337; *Brit. Chem. Abstr.* 1935B: 16. 97 references.

11. Bailey, A. J., The literature of wood and wood technology. *Paper Trade J. 109,* No. 22: 97–104 (Nov. 30, 1939); *Bull. Inst. Paper Chem. 10:* 116. 87 references.

12. Baldwin, H. E., TAPPI survey of water technology. Review of the literature for 1947. *Tappi 32,* No. 2: 86–90 (Feb., 1949); *Bull. Inst. Paper Chem. 19:* 510; *Brit. Abstr.* 1949B, II: 893. 113 references.

13. Baldwin, R. T., Chlorine and bleaching powder (bibliography of slime control). *Paper Trade J. 92,* No. 17: 54–5 (April 23, 1931); *Paper Mill 54,* No. 20: 18–19 (May 16, 1931); *Tech. Assoc. Papers 14,* No. 1: 201–2 (May, 1931); *Chem. Abstr. 25:* 5025. 36 references.

14. Barker, S. A., and Bourne, G. J., Enzymic synthesis of polysaccharides. *Quart. Revs. (London) 7,* No. 1: 56–83 (1953). *Bull. Inst. Paper Chem. 24:* 45. 179 references.

15. Barrett, F. L., Fibres, textiles, cellulose and paper. *Repts. Progr. Appl. Chem. 6:* 112–53 (1921). 307 references. *7:* 107–48 (1922). 341 references.

16. Barrows, F. L., Cellulose membranes from various parts of the plant kingdom. *Contrib. Boyce Thompson Inst. 11,* No. 1: 61–82 (Oct.–Dec., 1939); *Bull. Inst. Paper Chem. 10:* 185. 40 references.

17. Battye, A. E., and Marsh, J. T., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 28:* 102–17 (1943). 122 references.

18. Bauer, Oskar, The manufacture of water- and greaseproof papers—review of the recent patent literature. *Allgem. Papier-Rundschau* No. 8: 294–7; No. 10: 402–7 (April 24, May 22, 1951); *Bull. Inst. Paper Chem. 22*: 34; *Chem. Abstr. 45*: 10582. 77 references.

19. Beeman, L. A., and Reichert, J. S., Peroxides in pulp bleaching processes. Wilmington, Del., E. I. du Pont de Nemours & Co. (Inc.), Jan. 15, 1951. 106 pages. 117 references.

20. Bialkowsky, H. W., Hydration—bibliography. *Bull. Inst. Paper Chem. 1,* No. 4: 14–21 (Dec., 1930). 108 references.

21. Bibliography of articles on color and other optical properties of paper. *Tappi 35,* No. 4: 106A, 108A (April, 1952). 25 references.

22. Bibliography of current paper trade literature. *Paper Makers' Monthly J. 50:* 135–7, 174–7, 211–13, 250–3, 296–9, 341–3, 386–8, 433–5, 481–3 (1912); *51:* 21–3, 65–7, 117–19, 162–4, 208–9, 258–9, 301–3, 349–51, 392–4, 440–2, 521–2(1913); *52:* 18–19, 57–9, 95–7, 131–3, 175–7, 213–15, 248–9, 283–4, 314–15, 345–7, 380–2, 410–11 (1914); *53:* 19–20, 51–3, 114–16, 153–4, 189–90, 221–3, 284–6, 323–4, 353–5, 385–6 (1915); *54:* 14–15, 48–9, 75–6, 107–9, 139–40, 175–6, 211–12, 240–1, 273–4, 306–7, 336–8, 366–8 (1916); *55:* 14–15, 37–8, 70–1, 106–7, 137–9, 182–3, 219–20, 250–1, 278–9, 317–18, 345–7, 373–4 (1917); *56:* 9–10, 42–3, 79–80, 108–9, 140–1, 172–3, 198–9, 232–4, 260–2, 301–3, 329–31, 356–7 (1918); *57:* 12–13, 38–40, 70–2, 110–11, 140–1, 168–9, 199–201, 237–9, 267–9, 299–301, 331–2, 368–9 (1919); *58:* 4–5, 40–1, 73–4, 109, 149, 151, 176–7, 214–16, 252–3, 292–3, 335, 337, 371, 373, 416–17 (1920); *59:* 8–9, 71, 73, 92–3, 134–5, 209, 211, 231, 233, 279–80, 327, 329, 354–5, 389–90, 431–2, 467–8 (1921); *60:* 13–14, 55–6, 87–8, 121–2, 176–6, 211, 213, 249–50, 293–4, 329–30, 383, 385, 411–12, 465 (1922); *61:* 11, 13, 59, 61, 113–14, 146–47, 191–2, 232–3, 276–7, 319–20, 360–1, 412–13, 440–1, 497, 499 (1923); *62:* 13–14, 65–6, 100–1, 144–51, 194–5, 249–50, 293–4, 337–8, 370–1, 412–13, 451–2, 499–500 (1924); *63:* 5–6, 53–4, 89–90, 129–30, 170–1, 221, 223, 259–60, 290–1, 336–7, 375–6, 415–16, 453–4 (1925); *64:* 10–11, 60–1, 91–2, 128–9, 168–9, 208–9, 260–1, 308–9, 345–6, 381–2, 419–20, 463–4 (1926); *65:* 16–17, 50–1, 88–9, 134–5, 181, 183, 227, 229, 264–5, 319–20, 408–9, 355–6, 457, 459 (1927).

23. Bibliography of current trade literature. *Paper Makers Monthly J. 66,* No. 1: 13–14; No. 2: 62–3; No. 3: 106–7; No. 4: 166–7; No. 5: 212–13; No. 6: 252–3; No. 7: 309–10; No. 8: 362–3; No. 9: 396–7; No. 10: 453–4; No. 11: 486–7; No. 12: 534–5 (1928); *67,* No. 1: 12–13; No. 2: 48–9; No. 3: 96–7; No. 4: 153–4; No. 5: 198–9; No. 6: 234–5; No. 7: 278–9; No. 8: 329–30, No. 9: 379, 381; No. 10: 418–19; No. 11: 450–1; No. 12: 507–8 (1929); *68,* No. 1: 8–9; No. 2: 62–3; No. 3: 100–1; No. 4: 134–5; No. 5: 189–90; No. 6: 238–9; No. 7: 287, 289; No. 8: 325, 327; No. 9: 361–2; No. 10: 397–8; No. 11: 442–3; No. 12: 470–1 (1930); *69,* No. 1: 15–16; No. 2: 49–50; No. 3: 105–6; No. 4: 152–3; No. 5: 197–8; No. 6: 233–4; No. 7: 278–9; No. 8: 329–30; No. 9: 365–6; No. 10: 420–1; No. 11: 450–1; No. 12: 490–1 (1931); *70,* No. 1: 5–6; No. 2: 39–40; No. 3: 83–4 (1932).

24. Bibliography of paper making. *World's Paper Trade Rev. 98,* No. 3: 193–4; No. 8: 585–6; No. 13: 989–90; No. 19: 1476, 1478; No. 24: 1868, 1870 (1932); *99,* No. 10: 735–6, No. 15: 1146, 1149; No. 23: 1747–8; *100,* No. 7: 554, 556–7; No. 19: 1487–8 (1933); *101,* No. 10: 814, 816 (1934). Apparently discontinued.

25. Bibliography of permanence and durability of paper (1932). *Paper Trade J. 96,* No. 23: 44 (June 8, 1933); *Tech. Assoc. Papers 16,* No. 1: 296 (June, 1933).

26. Bibliography of pitch troubles. Causes and possible remedies. *Bull. Inst. Paper Chem. 3*: 41–51 (1932–33). 76 references.

27. Bibliography of pulp and paper manufacture. *Zellstoff u. Papier 8,* No. 1: 40–3; No. 2: 100–5; No. 3: 160–6; No. 4: 231–47; No. 5: 304–10; No. 6: 390–400; No. 7: 480–2; No. 8: 540–6; No. 9: 610–14; No. 10: 667–78; No. 11: 744–8; No. 12: 817–24 (1928); *9,* No. 1: 34–44; No. 2: 107–15; No. 3: 168–74; No. 4: 239–43; No. 5: 298–306; No. 6: 386–99; No. 7: 470–8; No. 8: 543–52; No. 9: 628–37; No. 10: 691–704; No. 11: 768–76; No. 12: 854–66 (1929); *10,* No. 1: 44–52; No. 2: 100–6, 108, 110–14; No. 3: 188–99; No. 4: 266, 268–79; No. 5: 338–46; No. 6: 413–25; No. 7: 507–16; No. 8: 581–8; No. 9: 656–67; No. 10: 730–6, 738, 740, 742, 744; No. 11: 789–802; No. 12: 886–90, 892, 894, 896, 898, 900 (1930); *11,* No. 1: 37–8, 40, 42–4, 46, 48, 50; No. 2: 100, 102–4, 106–10; No. 3: 158–62, 164, 166, 168; No. 4: 216, 218–20, 222–7; No. 5: 278–87; No. 6: 368–76, 378, 380; No. 7: 423–32; No. 8: 486, 488, 490–6; No. 9: 537–45; No. 10: 587, 591–2, 594–9; No. 11: 638, 644, 646–50; No. 12: 708, 714, 716–17 (1931); *12,* No. 1: 30, 32–7; No. 2: 82–9; No. 3: 122–30; No. 4: 168–76; No. 5: 203–11; No. 6: 253–4, 256, 258–60, 262; No. 7: 297–300, 302, 304, 306; No. 8: 332–6, 338–42, 344; No. 9: 372–4, 376, 378, 380, 382; No. 10: 411–12, 414, 416–18, 420, 422; No. 11: 454–62, 464; No. 12: 503–12, 514, 516 (1932); *13,* No. 1: 35–40, 42; No. 2: 75–86; No. 3: 130–6; No. 4: 171–80, 182–4; No. 5: 224–36; No. 6: 286–94, 296–8, 300–1; No. 7: 347–54, 356–8, 360; No. 8: 404–14; No. 9: 449–54, 456–60, 462–4; No. 10: 491–8, 500–2; No. 11: 528–36, 538–40, 542; No. 12: 585–94, 596 (1933); *14,* No. 1: 31–8, 40–2; No. 2: 65–78; No. 3: 113–18, 120–2, 124, 126, 128–9; No. 4: 162–6, 168, 170, 172, 174; No. 5: 210–14, 217–18, 220–4; No. 6: 248–54, 256, 260, 262; No. 7: 287–94, 296–8; No. 8: 328–34, 336, 338, 340–3; No. 9: 371–2, 374–6, 378, 380, 382–4; No. 10: 405–16, 418, 420, 422–4; No. 11: 452–8, 460, 462–4; No. 12: 522, 524, 526–34, 536–8 (1934); *15,* No. 1: 24–30, 32, 34, 36–8; No. 2: 65–70, 72, 74–80; No. 3: 112–18, 120, 122–6; No. 4: 166–70, 172, 174, 176, 178–82; No. 5: 210–16, 218, 220, 222; No. 6: 250–2, 254–6, 258–64; No. 7: 293–302; No. 8: 327–8, 330, 332–3, 336, 338–44; No. 9: 372, 374, 376–8, 380–4; No. 10: 409–16, 418–24; No. 11: 446–8, 450, 452, 454–6, 458, 460–1; No. 12: 526, 528, 530, 532, 534–40 (1935).

28. Bibliography of pulp and paper. 1936. *Zellstoff u. Papier 16,* No. 1: 28–32, 34, 36–40; No. 2: 67–72, 74–80; No. 3: 108–14, 116–22; No. 4: 147–8, 150, 152–6, 158–60, 162; No. 5: 189–90, 192–200; No. 6: 227–33, 236, 238–41; No. 7: 302, 304–6, 308–10, 312–14; No. 8: 359–62, 364, 366–8, 370, 372–4; No. 9: 429–34, 436, 438, 440, 442; No. 10: 476, 478–84, 486–8, No. 11: 520, 522–4, 526, 528, 530, 532, 534–5. No. 12: 617–20; 622, 624, 626, 628–30 (1936). *1937. Zellstoff u. Papier 17.* No. 1: 29–32, 34–8, 40–2; No. 2: 68, 70–4, 76–9; No. 3: 128, 130, 132, 134, 136, 138, 140, 142, 144, 146; No. 4: 168, 170,

172–6, 178, 180, 182; No. 5: 203–4, 206–10, 212, 214, 218; No. 6: 247–8, 250, 252, 254–6, 258–9; No. 7: 320, 322, 324–6, 328, 330, 332, 334, 336; No. 8: 364–6, 368–70, 372–4; No. 9: 407–8, 410–19; No. 10: 447–56; No. 11: 491–9; No. 12: 576–8, 580, 582, 584, 588, 590, 592, 594 (1937). *1938. Zellstoff u. Papier 18*: No. 1: 32–4, 36–8, 40; No. 2: 70, 72, 74–8, 80, 84, 86–7; No. 3, 154, 156, 158, 160, 162–4, 166, 168, 170; No. 4: 210–12, 214–18, 220; No. 5: 266, 268–70, 272–6; No. 6: 364, 366, 368, 370, 372–7; No. 7: 420–4, 426, 428, 430–2; No. 8: 488–94, 496; No. 9: 538, 540, 542–4, 546–54; No. 10: 602, 604, 606–12; No. 11: 648, 650–60, 662; No. 12: 738, 740, 742, 744, 746, 748, 750, 752–6, 758 (1938). *1939. Zellstoff u. Papier 19*, No. 1: 36–43; No. 2: 84–6, 88–92, 94, 96–8; No. 3: 158, 160–4, 166–8, 170, 172–4, 176, 178; No. 4: 230–2, 234–6, 238, 240; No. 5: 278–84, 286–91; No. 6: 386, 388, 390–2, 394–6; No. 7: 431–40, 442–3; No. 8: 488–90, 492, 494, 496–8; No. 9: 544, 546, 548, 550–2, 554, 556, 558–60; No. 10: 580, 582, 584; No. 11/12: 640, 642–4, 646 (1939). *1940. Zellstoff u. Papier 20*, No. 1: 18, 20–2, 24, 26; No. 2: 48, 50, 52–4; No. 3: 96–100, 102, 104, 106, 108; No. 5: 168, 170; No. 6: 194, 196–200, 202; No. 7: 222–6, 228–30; No. 8: 252, 254–8; No. 9: 280, 282, 284–6; No. 10: 308–12, 314; No. 11: 334, 336, 338–40, 342; No. 12: 384, 386, 388, 390, 392, 394, 396, 398 (1940); *21*, No. 2: 58, 60, 62; No. 3: 86, 88–90, 92, 94; No. 4: 126, 128–30, 132; No. 5: 162, 164, 166; No. 7: 220, 222–6, 228–30; No. 8: 256, 258, 260–2; No. 9: 286, 288–90, 292, 294 (1941).

29. Bikerman, J. J., A review of adhesion tests. PATRA, Packaging Bulletin No. 2. Jan., 1945. 23 p. Bibl. on nature and testing of adhesion, p. 19–23. *Bull. Inst. Paper Chem. 16*: 49; *Chem. Abstr. 39*: 3969.

30. Blanchard, E., Prehydrolysis of pentosan-rich plants with separation of pentoses and the preparation of high quality cellulose. II. Utilization of the hemicellulose resulting from the prehydrolysis of cellulosic raw materials. *Anales fis. y quim. 38*: A103–10, 110–18 (May, June, 1942). 38 references.

31. Blanchard, E., The structure of cellulose. *Ion* 3: 185–92 (1943). 35 references.

32. Blanco, G. W., Action of alkalies on cellulose. *Ind. Eng. Chem. 20*, No. 9: 926–30 (Sept., 1928); *Paper Makers' Monthly J. 66*, No. 12: 539–43 (Dec., 1928); *Chem. Abstr. 23*: 971. 66 references.

33. Boulton, J., and Morton, T. H., The dyeing of cellulose materials; a review of the physics and chemistry of the dyeing process. *J. Soc. Dyers Colourists 56*, No. 4: 145–59 (April, 1940); *Bull. Inst. Paper Chem. 10*: 417; *Chem. Abstr. 34*: 4575; *Brit. Chem. Physiol. Abstr.* 1940B: 439. 67 references.

34. Brauns, F. E., Lignin. *Fortschr. Chem. org. Naturstoffe 5:* 175–240 (1948); *Bull. Inst. Paper Chem. 19:* 702. 333 references.

35. Bray, M. W., Martin, J. S., and Smith, L. H., List of references to the literature of tall oil. Forest Products Laboratory, R1129. Aug., 1938. 9 p. 98 references. Processed.

36. Briggs, J. F., Fibres, textiles, cellulose and paper. *Repts. Progr. Appl. Chem. 2:* 126–58 (1917). 150 references. *3:* 115–46 (1918). 112 references.

37. Brother, G. H., Smith, A. K., and Circle, S. J., Soybean protein, résumé and bibliography. U. S. Dept. Agr., Agricultural Chemistry and Engineering Bureau, ACE-62. 64 p. Processed. 592 references.

38. Brounstein, C. J., Review of lesser-known pulping methods. *Proc. tech. Sect., Can Pulp Paper Assoc.* 1952: 211–23; *Pulp Paper Mag. Can. 53*, No. 3: 247–58, 263 (Feb., 1952); *Bull. Inst. Paper Chem. 22:* 573; *Chem. Abstr. 46:* 4793; *Brit. Abstr.* 1952B, II: 626. 106 references.

39. Browning, B. L., Chemical testing methods review. *1940. Tech. Assoc. Papers 24:* 391 (June, 1941); *Paper Trade J. 112*, No. 3: 31–2 (Jan. 16, 1941). 28 references. *1941. Tech. Assoc. Papers 25:* 137–8 (June, 1942); *Paper Trade J. 114*, No. 12: 41–2 (March 19, 1942). 37 references. *1942. Tech. Assoc. Papers 26:* 111–12 (June, 1943); *Paper Trade J. 116*, No. 11: 31–2 (March 18, 1943). 37 references.

40. Browning, B. L., and Calkin, J. B., The fatty acids in tall oil—a literature review. *Paper Trade J. 123*, No. 26: 45–7 (Dec. 26, 1946); *Bull. Inst. Paper Chem. 17:* 267; *Chem. Abstr., 41:* 857; *Brit. Abstr.* 1947B, II: 167. 14 references.

41. Byman, L., Tall oil from the consumer's viewpoint *Tech. Assoc. Papers 29:* 463–9 (June, 1946); *Paper Trade J. 123*, No. 22: 35–40 (Nov. 28, 1946); *Bull. Inst. Paper Chem. 17:* 204; *Chem. Abstr. 41:* 599. 111 references.

42. Cable, D. E., Bibliography of wood pulp strength testing. *Paper Trade J. 92*, No. 9: 35–9 (Feb. 26, 1931); *Chem. Abstr. 25:* 2285.

43. Cable, D. E., Pulp Testing developments 1931–1932. *Paper Trade J. 94*, No. 25: 27–30 (June 23, 1932); *97*, No. 1: 32–6 (July 6, 1933); *Tech. Assoc. Papers 15*, No. 1: 279–82 (June, 1932); *16*, No. 1: 322–6 (June, 1933). Bibl. at end of each year's review.

44. Cable, D. E., Pulp testing references for 1934. *Paper Trade J. 101*, No. 10: 36–40 (Sept. 5, 1935). Classified.

45. Calkin, J. B., Microscopy of paper. TAPPI Special Bibliography Series No. 1. 1937. 47 p.

46. Callow, H. J., Bast fibres—physics and chemistry. *Rev. Textile Progr. 1:* 63–82 (1949). 61 references. *2:* 23–27 (1950). 67 references.

47. Canadian Pulp and Paper Association. *Technical Section. Board Committee. Stock Preparation Sub-Committee.* Stock preparation monograph. I. Montreal, The Association, 1945. 40 p. Bibl. of 3 p. (1925–1944).

48. Canadian Pulp and Paper Association. *Technical Section. Sulphite Committee.* A bibliography of papers on the sulphite process. *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1952: 316–20; *Bull. Inst. Paper Chem. 23:* 441.

49. Canadian Pulp and Paper Association. *Technical Section. Waste Committee.* Bibliographic review of stream pollution. Montreal, The Association, Nov., 1950. 23 p. 78 references.

50. Canadian Pulp and Paper Association. *Woodlands Section.* Classified list and index of information on woods operations contained in the publications and circulars issued by the Woodlands Section, 1927–1938. 1940. 18 p. Mimeograph supplements, 1939–1945. 775 titles.

51. Carey, W. G., Sewage, river pollution and trade wastes. *Repts. Progr. Appl. Chem. 36:* 88–98 (1951); *Bull. Inst. Paper Chem. 23:* 127. 24 references.

52. Carothers, W. H., Polymerization. *Chem. Revs. 8*, No. 3: 353–426 (June, 1931). Cellulose, p. 406–8. Extensive bibliography. Abstract in *Forest Products Labs. Can., Pulp Paper Lab., Quart. Rev.*, No. 6: 1–16 (April–June, 1931).

53. Carson, F. T., Bibliography on paper sizing. *Natl. Bur. Standards (U. S.), Technol. Papers* No. 326, 1926. Bibl. p. 730–2. *Tech. Assoc. Papers 10*, No. 1: 145 (1927); *Paper Trade J. 84*, No. 11: 43–4 (March 17, 1927).

54. Casciani, F., Preparation of chlorine dioxide. *Paper Trade J. 135*, No. 10: 22, 24, 26, 28, 30, 32 (Sept. 5, 1952); *Bull. Inst. Paper Chem. 23:* 92. 112 references.

55. Casciani, F., Uses of chlorine dioxide and chlorites in pulp and paper. *Paper Trade J. 136*, No. 10: 21–5 (March 6, 1953); *Bull. Inst. Paper Chem. 23:* 630. 108 references.

56. Casey, R. S., and Grove, C. S., Jr., Fibers [as constructional materials]. *Ind. Eng. Chem. 39*, No. 10: 1213–15 (Oct., 1947). 40 references. *40*, No. 10: 1793–8 (Oct., 1948). 273 references. *41*, No. 10: 2119–21 (Oct., 1949). 107 references.

57. Cassiday, W. L., Bibliography of starch in its relation to the manufacture of paper. *Bull. Inst. Paper Chem. 1*, No. 9: 23–37 (May, 1931). 107 references.

58. Champetier, G., Recent advances in the study of the structure and reactions of cellulose. *Bull. soc. chim.* (5) *1*, No. 5: 613–35 (May, 1934). 84 references.

59. Chapman, S. M., Bibliography of articles on printability and related subjects. 1941–1942. *Pulp Paper Mag. Can. 44*, No. 2: 206, 208, 210, 212, 214, 216, 218, 220 (Feb., 1943); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1943: 43–9; *Bull. Inst. Paper Chem. 13:* 326. 51 references. 1942–1943. *Pulp Paper Mag. Can. 45*, No. 3: 201–4, 256, 258 (Feb., 1944); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1944: 40–5; *Paper-Maker*, Midsummer Special 1944: 31–2, 35–6; *Paper Box Bag Maker 98*, No. 1: 14–15, 17–18 (July, 1944). 24 references. *1943–1944. Pulp Paper Mag. Can. 46*, No. 3: 265–70 (Feb., 1945); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1945: 21–6; *Bull. Inst. Paper Chem.* 15: 298. 36 references.

60. Chapman, S. M., A review of the literature on printability and allied subjects. 1945–1946. *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1947: 42–8; *Pulp Paper Mag. Can. 48*, No. 5: 75–81 (April, 1947); *Bull. Inst. Paper Chem. 17:* 647; *Chem. Abstr. 41:* 4919. 38 references. *1946–1947. Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1948: 33–40; *Pulp Paper Mag. Can. 49*, No. 3: 107–14 (Jan., 1948); *Bull. Inst. Paper Chem. 18:* 542; *Chem. Abstr. 42:* 4751. 43 references. *1947–1949. Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1950: 197–205. 62 references.

61. Chapman, S. M., A review of the literature relating to printability and allied subjects. 1944–1945. *Pulp Paper Mag. Can. 47*, No. 3: 267–73 (Feb., 1946); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1946: 32–9; *Paper Ind., 27*, No. 11: 1704–9 (Feb., 1946); *Bull. Inst. Paper Chem. 16:* 409. 47 references. 1945–1946. *Pulp Paper Mag. Can. 48*, No. 5: 75–81 (April, 1947); *Proc. Tech. Sect., Can. Pulp Paper Assoc.*, 1947: 42–8; *Bull. Inst. Paper Chem. 17:* 647; *Chem. Abstr. 41*: 4919.

62. Charch, W. H., Rayon. *Ann. Survey Am. Chem. 2:* 352–61 (1927). 76 references. *3:* 324–8 (1928). 36 references.

63. Cirves, F. J., Developments in the bleaching of pulp. *Paper Ind. 18*, No. 4: 285–9 (July, 1936); *Bull. Inst. Paper Chem. 6:* 455; *Brit. Chem. Abstr.* 1936B: 980. 28 references.

64. Clark, N., TAPPI literature relating to coated paper. *Paper Trade J. 92*, No. 13: 53–5 (March 26, 1931).

65. Clifford, P. H., and Fargher, R. G., "Oxycellulose." Its formation and reactions. A summary of the literature.

J. Textile Inst. 13: 189–204 (Oct., 1922); *Am. Dyestuff Reptr. 11:* 405, 427 (1922). 90 references.

66. Collins, G. E., Some physical properties of cotton cellulose and its modifications. A summary of existing data. *J. Textile Inst. 13:* 204–13 (Oct., 1922). 87 references.

67. Collins, G. E., The swelling of cotton cellulose. *Shirley Inst. Mem. 2:* 213–16 (1923); *J. Textile Inst. 14:* 264–7T (1923); *Am. Dyestuff Reptr. 12:* 669–77 (1923). 200 references.

68. Collins, T. T., Jr., The corrosion and lining of sulphate digesters. *Paper Trade J. 130,* No. 21: 32–4, 36, 38; No. 22: 20-2 (May 25, June 1, 1950). An annotated bibliography with 36 references.

69. Collins, T. T., Jr., The oxidation of sulphate black liquor. *Paper Trade J. 136,* No. 12: 37–40; No. 13: 19–22, 24 (March 20, 27, 1953); *Bull. Inst. Paper Chem. 23:* 623. 67 references.

70. Collins, T. T., Jr., Review of the literature on wet strength paper. *Paper Ind. 25,* No. 3: 263–9 (June, 1943); *Bull. Inst. Paper Chem. 13:* 455; *Chem. Abstr. 37:* 4896. 96 references.

71. Collins, T. T., Jr., Sulphite turpentine—a review of the literature. *Paper Ind. 27,* No. 4: 537–41; No. 5: 719–22 (July, Aug., 1945); *Bull. Inst. Paper Chem. 16:* 41. 103 references.

72. Collins, T. T., Jr., Zein—its use in coatings. *Paper Ind. 27,* No. 11: 1694–7; No. 12: 1810–16 (Feb., March, 1946). 139 references.

73. Collins, T. T., Jr., and Adrian, A., Wet strength paper—a review of the literature. *Paper Mill News 72,* No. 17: 26, 28, 30, 32–3; No. 18: 10, 12, 14; No. 19: 9–10; No. 20: 16–18; No. 21: 28, 30, 32; No. 22: 12–13; No. 23: 10, 12; No. 24: 12, 14; No. 25: 12, 14; No. 26: 40–2; No. 28: 14, 16, 20, 22; No. 34: 24 (April 23, 30, May 7, 14, 21, 28, June 4, 11, 18, 25, July 9, Aug. 20, 1949); *Bull. Inst. Paper Chem. 19:* 879. Also issued as a reprint (87 p.) by The American Pulp and Paper Mill Superintendents Association, Chicago, Ill. 425 references.

74. Committee on Paper Testing. Paper testing. *Paper Trade J. 75,* No. 7: 48–9 (Aug. 17, 1922). 152 references.

75. Compton, J., The molecular constitution of cellulose. *Advances in Carbohydrate Chem. 3:* 185–228 (1948); *Bull. Inst. Paper Chem. 18:* 655. 161 references.

76. Conrad, C. M., Molecular weight uniformity of cellulose and cellulose derivatives; recent development in measurement. *Ind. Eng. Chem. 45,* No. 11: 2511–17 (Nov., 1953); *Bull. Inst. Paper Chem. 24:* 287. 68 references.

77. Cousins, C. R., Goldin, J., and Davis, D. S., Literature on freeness. *Tech. Assoc. Papers 22:* 418–28 (June, 1939). 172 references from 1907 to 1938. Annotated.

78. Cragg, L. H., and Hammerschlag, H., The fractionation of high-polymeric substances. *Chem. Revs. 39,* No. 1: 79–135 (Aug., 1946); *Bull. Inst. Paper Chem. 17:* 56. 312 references.

79. Crain, R. C., Bleaching of rag half stock by calcium hypochlorite. *Paper Trade J. 103,* No. 24: 37–46 (Dec. 10, 1936); *Papier 40,* No. 3: 213–14, 216–17, 221–2, 225–6, 229–31 (March, 1937); *Bull. Inst. Paper Chem. 7:* 136; *Chem. Abstr. 31:* 2425; *Brit. Chem. Abstr.* 1937B: 125. 111 references.

80. Davidson, G. F., The molecular structure of cellulose. I. A review of current theories. II. The evidence of the chemically modified cotton cellulose. *J. Textile Inst. 27,* No. 7: P144–68 (July, 1936); *Silk and Rayon, 10,* No. 7: 546, 548 (July, 1936); *Shirley Inst. Mem. 15:* 1–23 (1936); *Bull. Inst. Paper Chem. 7:* 5; *Chem. Abstr. 31:* 1999; *Brit. Chem. Abstr.* 1936B: 1034. 108 references.

81. Day, E., Cotton linters—selected references in English, 1900–July, 1940. U. S. Dept. Agr., Agricultural Economic Bibl. 88. Oct., 1940. vi + 39 + [6] p. Processed.

82. Derry, R. L., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 31:* 142–70 (1946). 198 references.

83. Derry, R. L., and Roff, W. J., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 32:* 226–44 (1947). 211 references.

84. Dorée, C., Fibres, textiles, cellulose, and paper. *Repts. Progr. Appl. Chem. 8:* 129–61 (1923). 165 references.

85. Dossel, A., and Merlau, M., Bibliography of pulp and paper making. *Zellstoff u. Papier 7,* No. 2: 66–9; No. 3:121–3; No. 4: 164–6; No. 5: 203–6; No. 6: 243–6; No. 8: 381–6; No. 10: 477–82; No. 11: 536–8; No. 12: 600–2 (1927); *8,* No. 1: 40–3; No. 3: 162–6; No. 4: 231–47; No. 5: 304–10; No. 6: 390–400 (1928).

86. Doudoroff, P., and Katz, M., Critical review of literature on the toxicity of industrial wastes and their components to fish. I. Alkalies, acids, and inorganic gases. *Sewage Ind. Wastes 22,* No. 11: 1432–58 (Nov., 1950). 126 references.

87. Doudoroff, P., and Katz, M., Critical review of literature on the toxicity of industrial wastes and their components to fish. II. The metals, as salts. *Sewage Ind. Wastes 25,* No. 7: 802–39 (July, 1953); *Bull. Inst. Paper Chem. 23:* 919. 155 references.

88. Dryden, E. C., Aronovsky, S. I., and Jarrell, T. D., Utilization of farm wastes for paper and board making. *Paper Ind. 21,* No. 9: 972–7 (Dec., 1939); *Bull Inst Paper Chem. 10:* 172; *Chem. Abstr. 34:* 2597; *Brit. Chem. Physiol. Abstr.* 1940B: 270. 94 references.

89. Duclaux, J., Colloidal state of cellulose and its derivatives. Dixiéme Conference de l'Union Internationale de Chemie, 1930: 214–37. 108 references.

90. Dumercy, C., Bibliographie de la papeterie. Bruxelles, Ferdinand Larcier, 1888. 28 p. *Translation* by Dard Hunter. *Paper Trade J. 72,* No. 11: 56, 58, 60, 62, 64, 66; No. 12: 54, 56, 58, 60, 62 (March 10, 17, 1921).

91. Dunn, C. G., Food yeast. *Wallerstein Labs. Communs. 55,* No. 48: 61–79 (March, 1952); *Bull. Inst. Paper Chem. 22:* 703. 213 references.

92. DuPont, G., The chemistry of lignin. *Chimie et industrie 19,* No. 1: 3–23; No. 3: 407–16 (Jan., March, 1928); *Pulp Paper Mag. Can. 26,* No. 35: 1183–8; No. 36: 1235–6, 1254, 1256, 1258; No. 37: 1267–8; No. 38: 1297–1300, 1326 (Aug. 30–Sept. 6, 13, 20, 1928); *Chem. Abstr. 22:* 3291, 4796. 104 references.

93. Edge, S. R. H., Pulp and paper. *Repts. Progr. Appl. Chem. 22:* 252–66 (1937). 100 references. 35: 513–24 (1950). 70 references. *36:* 517–24 (1951). 40 references.

94. Effect of bleaching on the physical and chemical constants of pulps—bibliography. *Bull Inst. Paper Chem. 1,* No. 6: 16–25 (Feb., 1931).

95. Ehrmann, P., General study of cellulose and its principal derivatives. *Caoutchouc and gutta percha 23:* 13030–2, 13064–5, 13099–13102, 13138–9, 13175–6, 13275–6 (1926). 126 references.

96. Eisner, A., Advances in the field of artificial leather manufacture in the years 1935 and 1936. *Nitrocellulose 8,* No. 3: 39–42; No. 4: 56–8; No. 5: 77–8 (March, April, May, 1937); *Bull. Inst. Paper Chem. ?:* 376. Patent review.

97. Eisner, A., Further advances in the manufacture of leather substitutes. *Nitrocellulose 9,* No. 5: 81–2; No. 6: 98–100 (May, June, 1938). Patent review.

98. Ellis, C., Tailoring the long molecule. Plastics. *Ind. Eng. Chem. 28,* No. 10: 1130–44 (Oct., 1946); *Bull. Inst. Paper Chem. ?:* 85. Includes discussion of cellulose. 75 references.

99. Entwhistle, D., Rayon—physics and chemistry *Rev. Textile Progr. 1:* 47–62 (1949). 95 references.

100. Entwhistle, D., Rayon and other manufactured fibres—physics and chemistry. *Rev. Textile Progr. 2:*63–79 (1950). 86 references. *3:*90–107 (1951). 92 references.

101. Erdtman, H., Chemistry of some heartwood constituents of conifers and their physiological and taxonomic significance. *Progr. Org. Chem. 1:* 22–63 (1952); *Bull. Inst. Paper Chem. 23:* 285; *Chem. Abstr. 46:* 8605. 164 references.

102. Erdtman, H., Some heartwood constituents of the natural order *Pinales. Holz Roh- u. Werkstoff 11,* No. 7: 235–51 (July, 1953); *Bull. Inst. Paper Chem. 24:* 61. 58 references.

103. Farrow, F. D., Sizing—a review of the literature. *Shirley Inst. Mem. 2:* 194–203 (1923); *Color Trade J. 13:* 146–51 (1923). 54 references.

104. Flax. Department of Technical Control, American Writing Paper Co., Holyoke, Mass. 163 entries. 1880–1920. Abstracts.

105. Fordyce, C. R., Cellulose esters of organic acids. *Advances in Carbohydrate Chem. 1:* 309–27 (1945). 57 references.

106. Foreign paper making patents. *Zellstoff u. Papier 13,* No. 6: 276–80; No. 12: 567–70 (June, Dec., 1933); *14,* No. 4: 153–7; No. 8: 321–5; No. 12: 509–13 (April, Aug., Dec., 1934). Classified.

107. Foreign patents on papermaking. *Zellstoff u. Papier 16,* No. 3: 103–4; No. 4: 142–4; No. 5: 182; No. 11: 512–13; No. 12: 602, 604, 606 (March, April, May, Nov., Dec., 1936); *17,* No. 3: 115–19, No. 6: 237–41; No. 11: 480–4 (March, June, Nov., 1937); *18,* No. 5: 254–8, 260; No. 7: 410–13; No. 12: 714–18 (May, July, Dec., 1938); *19,* No. 7: 422–5 (July, 1939); *20,* No. 1: 14–16; No. 2: 45–7 (Jan., Feb., 1940).

108. Freudenberg, K., Lignin. FIAT review of German science 1939–1946, Biochemistry, Part III: 159–84 (1948); *Bull. Inst. Paper Chem. 20:* 321. 88 references.

109. Freudenberg, K., Polysaccharides. FIAT review of German science 1939–1946, Biochemistry, Part III: 139–58(1948). Includes cellulose. 125 references.

110. Friedman, S. J., Drying. *Ind. Eng. Chem. 39,* No. 1: 20–1, 38–9 (Jan., 1947). 94 references. *40,* No. 1: 18–22 (Jan., 1948). 163 references. *41,* No. 1: 27–31 (Jan., 1948). 178 references. *42,* No. 1: 38–44 (Jan., 1950). 237 references. *43,* No. 1: 70–5 (Jan., 1951). 185 references.

111. Fuchs, W. M., Survey of the literature on cellulose and allied substances—1938–1940. VI. Relation of cellulose and lignin to the formation of peat and coal. *Tech. Assoc. Papers 25:* 724 (June, 1942). 15 references.

112. Fuller, C. S., The investigation of synthetic linear polymers by x-rays. *Chem. Revs. 26,* No. 2: 143–67 (April, 1940); *Bull. Inst. Paper Chem. 10:* 363. 76 references.

113. Gabrielson, C. O., The composition of tall oil and its distillation products. *Iva 21,* No. 4: 162–84 (1950); *Bull. Inst. Paper Chem. 21:* 655; *Chem. Abstr. 45:* 5404. 106 references.

114. Geissler, Adalbert, Literature of pulp and paper manufacture. (Mechanical part): 1916. *Wochbl. Papierfabrik. 48,* No. 8: 321–2; No. 11: 457–8; No. 12: 512–13; No. 13: 522–3; No. 15: 649–51; No. 16: 701–2; No. 20: 884–5; No. 22: 971–3; No. 24: 1067–8; No. 25: 1103–5; No. 28: 1234–5; No. 29: 1275–6; No. 30: 1323–4 (1917). *1917. Wochbl. Papierfabrik. 48,* No. 33: 1446–8; No. 35: 1530–1; No. 45: 1978–9; No. 49: 2150; No. 51: 2248; No. 52: 2299–2300 (1917). *49,* No. 1: 12; No. 3: 49; No. 5: 192; No. 7: 279–80; No. 8: 329; No. 9: 370; No. 10: 422; No. 11: 465; No. 13: 559–60; No. 14: 608; No. 15: 648; No. 16: 704 (1918). *1918. Papier-Ztg. 44,* No. 1: 3–4; No. 6: 131–2; No. 7: 159; No. 12: 290–1; No. 14: 355; No. 15: 379–80; No. 17: 442-3 (1919). *1919. Wochbl. Papierfabrik. 50,* No. 18: 1049–51; No. 21: 1232–3; No. 23: 1362; No. 25: 1500–1; No. 29: 1755–6; No. 35: 2167; No. 37: 2315–16; No. 41: 2604–5; No. 49: 3177–8; No. 51: 3321–2 (1919); *51:* 487–8, 638, 849–51, 990-1, 1207–8 (1920). *1920. Papier-Ztg. 45,* No. 55: 1958–9; No. 57: 2028; No. 90: 3298; No. 91: 3345–6; No. 92: 3385–6 (1920); *46,* No. 32: 1378–9; No. 33: 1411; No. 35: 1466; No. 36: 1496; No. 50: 1895; No. 51: 1923; No. 63: 2266 (1921). *1921. Zellstoff u. Papier 1,* No. 1: 28–31; No. 3: 88–91 (1921). Reprinted with the title Auszüge aus der Literatur der Zellstoff- und Papierfabrikation (Mechanischer Teil). 1916, 48 p.; 1917, 54 p.; 1918, 42 p.; 1919, 62 p.; 1920, 36 p.

115. Gerber, B. A., Bibliographic index of the literature on sizing. *Leningrad Oblastnoi Sovet. Nauch. Inzhenerno-Tekh. Obshchestva Tzellyuloz-Bumazhi Promi.* 1935, No. 5: 179–212; *Chem. Abstr. 30:* 5036.

116. German patent list. *Zellstoff u. Papier 16,* No. 1: 26; No. 2: 63; No. 3: 105; No. 4: 145; No. 5: 185; No. 6: 224; No. 7: 295; No. 8: 356; No. 9: 424; No. 10: 473; No. 11: 516; No. 12: 610 (1936); *17,* No. 1: 26; No. 2: 64; No. 3: 123; No. 4: 166; No. 5: 201; No. 6: 244; No. 7: 316, 318; No. 8: 361; No. 9: 404; No. 10: 443; No. 11: 488; No. 12: 571 (1937); *18,* No. 1: 28; No. 2: 67; No. 3: 148; No. 4: 207; No. 5: 261; No. 6: 358; No. 7: 415; No. 8: 484; No. 9: 534; No. 10: 594; No. 11: 643; No. 12: 726 (1938); *19,* No. 1: 34; No. 2: 78; No. 3: 146; No. 4: 227; No. 5: 275; No. 6: 382; No. 7: 328; No. 8: 481; No. 9: 540; No. 10: 578; No. 11/12: 632 (1939).

117. German patents. *Zellstoff u. Papier 10,* No. 3: 183–4; No. 4: 260; No. 5: 333–4; No. 6: 411; No. 7: 503; No. 8: 575; No. 9: 651; No. 10: 723–4; No. 11: 783; No. 12: 879–80 (1930); *11,* No. 3: 152; No. 4: 211; No. 5: 272; No. 6: 364; No. 7: 420; No. 8: 481; No. 9: 535; No. 10: 583; No. 11: 634; No. 12: 703 (1931); *12,* No. 1: 26; No. 2: 78; No. 3: 121; No. 4: 167; No. 5: 202; No. 6: 252; No. 7: 296; No. 8: 330; No. 9: 366–7; No. 11: 449; No. 12: 501 (1932); *13,* No. 1: 30; No. 2: 72; No. 3: 126; No. 4: 168; No. 5: 219; No. 6: 284; No. 7: 344; No. 8 400; No. 10: 488; No. 11: 525; No. 12: 581 (1933); *14,* No. 1: 28; No. 2: 63; No. 3: 107–8; No. 4: 159; No. 5: 208–9; No. 6: 246; No. 7: 284; No. 8: 326; No. 9: 368; No. 10: 401; No. 11: 448; No. 12: 516 (1934); *15,* No. 1: 21; No. 2: 62; No. 3: 109; No. 4: 163; No. 5: 208; No. 6: 247; No. 7: 290; No. 8: 325; No. 9: 369; No. 10: 406; No. 11: 442; No. 12: 520 (1935).

118. German patents in the paper industry [references to abstracts in Zellstoff und Papier]. *Zellstoff u. Papier 16,* No. 1: 23–5; No. 2: 61–3 (Jan., Feb., 1936); *17,* No. 1: 22–4; No. 2: 59–62 (Jan., Feb., 1937); *18,* No. 1: 23–4, 26; No. 3: 137–9 (Jan., March, 1938); *19,* No. 1: 29–30, 32; No. 3: 137–9 (Jan., March, 1939).

119. Gibbons, G. C., and Harland, W. G., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 36:* 525–45 (1951); *Bull. Inst. Paper Chem. 23:* 130. 155 references.

120. Gibbs, R. D., Studies of wood. I. The cell wall. *Can. J. Research 12,* No. 6: 715–26 (June, 1935). 70 references. *Chem. Abstr. 29:* 5623.

121. Gibbs, R. D., Studies of wood. II. The water content of certain Canadian trees and changes in the water-gas system during seasoning and flotation. *Can. J. Research 12,* No. 6: 727–61 (June, 1935). 36 references. *Chem. Abstr. 29:* 5623.

122. Gibbs, R. D., Studies of wood. III. The physiology of the tree, with special reference to the ascent of sap and the movement of water before and after death. *Can. J. Research 12,* No. 6: 761–87 (June, 1935). 207 references. *Chem. Abstr. 29:* 5624.

123. Gilbert, E. E., and Jones, E. P., Sulfonation and sulfation. *Ind. Eng. Chem. 44,* No. 9: 2082–2100 (Sept., 1952); *Bull. Inst. Paper Chem. 23:* 128. Includes lignosulphonates. 413 references.

124. Glennie, D. W., and Schwartz, H., Review of the literature on decay in pulpwood, its measurement and its effect on wood properties and pulp quality. Canada, Dept. Resources and Development, Forestry Branch, Forest Products Laboratories, Mimeograph O-153. March, 1950. 22 p. 67 references.

125. Gourley, S., Pentaerythritol-tall oil esters. A review of their preparation and uses in surface coatings. *J. Oil & Colour Chemists' Assoc. 33:* 175–9 (April, 1950). 32 references.

126. Graap, E., Literature of the pulp and paper industry. Chemical part. *Zellstoff u. Papier 3,* No. 8: 195–8; No. 9: 207–9; No. 10: 225–31; No. 12: 261–5 (1923); *4,* No. 1: 4–7; No. 2: 19–22; No. 5: 92–7; No. 6: 127–30; No. 8: 201–4; No. 9: 240–2; No. 11: 293–6; No. 12: 329–33 (1924); *5,* No. 2: 61–5; No. 3: 98–101; No. 6: 225–30; No. 7: 268–71; No. 9: 368–77; No. 12: 490–4 (1925); *6,* No. 1: 44–7; No. 3: 134–7; No. 4: 177–9; No. 7: 316–21; No. 8: 403–6; No. 10: 445–9; No. 11: 483–6; No. 12: 526–32 (1926); *7,* No. 1: 27–9; No. 2: 64–6; No. 3: 119–21; No. 4: 162–4; No. 5: 201–3; No. 6: 241–3; No. 8: 377–81; No. 9: 431–2; No. 10: 483–7; No. 11: 538–40; No. 12: 602–4 (1927); *8,* No. 2: 100–5; No. 3: 160–2 (1928).

127. Grace, H. P., Resistance and compressibility of filter cakes. Parts I–III. *Chem. Eng. Progr. 49,* No. 6: 303–18; No. 7: 367–77; No. 8: 427–36 (June, July, Aug., 1953). *Bull. Inst. Paper Chem. 24:* 102. 70 references.

128. Graff, J. H., Microscopy of pulp and paper. Bibliographic Series No. 177. Appleton, Wis., The Institute of Paper Chemistry, 1952. 398 p. 1370 references.

129. Graff, J. H., Pulp and paper microscopy. 2d ed. Appleton, Wis., Institute of Paper Chemistry, 1942. 193 p. Processed.

130. Grant, J., Paper technology in 1936. *World's Paper Trade Rev. 107,* No. 18: TS2–7 (April 30, 1937); *Bull. Inst. Paper Chem. 7:* 340. 69 references.

131. Grant, J., Pulp and paper. *Repts. Progr. Appl. Chem. 21:* 182–216 (1936). 143 references. *25:* 158–74 (1940). 84 references. *26:* 139–53 (1941). 76 references. *27:* 143–54 (1942). 75 references. *28:* 118–31 (1943). 76 references. *29:* 123–35 (1944). 70 references. *30:* 138–48 (1945). 75 references. *31:* 171–81 (1946). 69 references.

132. Gray, H. L., Cellulose. *Ann. Survey Am. Chem. 1:* 177–81 (1927). 32 references.

133. Gray, H. L., and Staud, C. J., Recent advances in cellulose and starch chemistry. *Chem. Revs. 4:* 355–73 (1927); *Tech. Chem. Papier- u. Zellstoff-Fabr. 25,* No. 6: 85–92 (June 30, 1928); *Paper Maker 77,* No. 5: 462H–3; No. 6: 612–13 (May, June, 1929); *Chem. Abstr. 22:* 1038. 104 references.

134. Great Britain. *Patent Office.* British patent office library accession. A select bibliography of cellulose, paper and allied subjects. Arranged by M. Hubbard. *Paper 25,* No. 4: 32, 34, 36, 38, 40, 41, 44, 46, 48, 50, 52; No. 9: 15–19; No. 10: 25 (Oct. 1, Nov. 5, 12, 1919).

135. Green, J. W., The halogen oxidation of simple carbohydrates, excluding the action of periodic acid. *Advances in Carbohydrate Chem. 3:* 129–84 (1948). 180 references.

136. Grove, C. S., Jr., Vodonik, J. L., and Casey, R. S., Fibers. *Ind. Eng. Chem. 42,* No. 10: 1983–6 (Oct., 1950). 134 references. *44,* No. 10: 2318–24 (Oct., 1952). 179 references.

137. Grunewald, W., Literature of the pulp and paper industry, mechanical part. *Zellstoff u. Papier 2,* No. 2: 43–50; No. 4: 92–8; No. 5: 121–8; No. 6: 144–9; No. 7: 170–4; No. 8: 192–7; No. 10: 246–51; No. 11: 273–7; No. 12: 294–6 (1922); *3,* No. 11: 22–4; No. 6: 150–6; No. 7: 174–82; No. 11: 244–8; No. 12: 272–3(1923); *4,* No. 2: 25–6; No. 3: 38–41 (1924).

138. Gustafsson, G. R., A literature review of the methods for determining lignin content, cooking degree, and bleachability of pulp. *Paper and Timber (Finland) 32,* No. 4A: 45–50; No. 5: 145–51; No. 6: 177–85 (April, May, June, 1950); *Bull. Inst. Paper Chem. 20:* 858. 361 references.

139. Gustafsson, G. R., Review of the literature on the influence of paper upon the printed result. *Paper and Timber (Finland) 32,* No. 4: 104–7 (April, 1950). 60 references.

140. Gustafsson, G. R., Review of literature on methods for determination of lignin content, cooking degree, and bleachability of sulphite pulp. *Meddel. Ind. Centrallab., Finland.* No. 83 1951. 73 p.

141. Hägglund, E., Advances in cellulose and wood pulp manufacture during the past year. *Z. angew. Chem. 41:* 6–14 (1928). 89 references.

142. Hagen, J. F., Literature survey of textile bleaching. *Am. Dyestuff Reptr. 39,* No. 20: P663–6; No. 21: P703–14; No. 22: P739–50; No. 23: P782–6; No. 24: P820–30 (Oct. 2, 16, 30, Nov. 13, 27, 1950); *Bull. Inst. Paper Chem. 21:* 229. 719 references.

143. Halle, — —., Paper and Pulp masses. *Kunststoffe 6:* 269–73, 289–92, 304–11 (1916). 259 patents.

144. Harris, E. E., Wood saccharification. *Advances in Carbohydrate Chem. 4:* 153–88 (1949). 154 references.

145. Harrison, H. A., Pulp and paper. *Repts. Progr. Appl. Chem. 17:* 166–88 (1932). 134 references. *18:* 165–94 (1933). 189 references. *20:* 190–219 (1935). 132 references.

146. Harrison, V. G. W., Definition and measurement of gloss—a survey of published literature. London, PATRA, Dec., 1945. 145 p. 180 references.

147. Harrison, V. G. W., Measurement of opacity of paper; a theoretical survey. *Proc. Tech. Sect., Paper Makers' Assoc. Gt. Brit. & Ireland 21:* 67–168; discussion, 169–73 (Oct., 1940); *World's Paper Trade Rev. 113,* No. 10: *TS*18–31; No. 14: *TS*36–47; No. 18: *TS*53–62; No. 22: *TS*66–72; No. 26: *TS*74–9;

114, No. 4: *TS*82–8; No. 12: *TS*98–102; No. 16: *TS*105–12; No. 24: *TS*128–9 (1940); *Paper-Maker (London) 99*, No. 4: *TS*28–32; No. 5: *TS*33–9; No. 6: *TS*41–8; *100*, No. 1: *TS*49–56; No. 2: *TS*57–64; No. 3: *TS*65–75; No. 4: *TS*77–84 (1940); *Bull. Inst. Paper Chem. 10:* 391; *Chem. Abstr. 34:* 8276; *Paper Making Abstr. 1:* 67; *Brit. Chem. Physiol. Abstr.* 1941B, II: 44. 78 references.

148. Haskins, J. F., Cellulose ethers of industrial significance. *Advances in Carbohydrate Chem. 2:* 279–94 (1946). 50 references.

149. Hasselstrom, T., Pine tree resenes in the biogenesis of the resin acids. *Paper Trade J. 128*, No. 7:17–21 (Feb. 17, 1949); *Bull. Inst. Paper Chem. 19*: 512; *Chem. Abstr. 43:* 5947; *Brit. Abstr.* 1949B, II:658. 48 references.

150. Hassid, W. Z., The chemistry of the carbohydrates. *Ann. Rev. Biochem. 13:* 59–92 (1944); *Bull. Inst. Paper Chem. 15:* 64. 110 references.

151. Hearle, J. W. S., The electrical resistance of textile materials—a review of the literature. *J. Textile Inst. 43*, No. 4: P194–223 (April, 1952); *Bull. Inst. Paper Chem. 22:* 777.

152. Hegan, H. J., Rayon. *Rev. Textile Progr. 1:* 143–67 (1949). 208 references.

153. Heidt, L. J., Gladding, E. K., and Purves, C. B., Oxidants that promote the dialdehyde cleavage of glycols, starch, and cellulose. *Tech. Assoc. Papers 28:* 178–86 (June, 1945); *Paper Trade J. 121*, No. 9: 35–43 (Aug. 30, 1945); *Paper Mill News 68*, No. 49: 76, 78, 82, 84, 86, 88, 90, 92, 94 (Dec. 8, 1945); *Bull. Inst. Paper Chem. 16:* 53; *Chem. Abstr. 40:* 546. 50 references.

154. Helleur, D. E., Classification of ammonia-base pulping literature. *Tappi 37*, No. 1: 177–82A (Jan., 1954). 146 references.

155. Hess, R. W., Bibliography on chemical wastes. *Ind. Eng. Chem. 39*, No. 5: 676–82 (May, 1947); *Bull. Inst. Paper Chem. 17:* 590.

156. Heukelekian, H., *et al.*, A critical review of the literature of 1952 on sewage, waste treatment, and water pollution. *Sewage Ind. Wastes 25*, No. 5: 511–47; No. 6: 633–83 (May, June, 1953); *Bull. Inst. Paper Chem. 23:* 828. 634 references.

157. Heuser, E., The nature of cellulose. *Paper Trade J. 101*, No. 21: 39–46; No. 22: 35–41; No. 23: 39–42 (Nov. 21, 28, Dec. 5, 1935); *Am. Dyestuff Reptr. 25:* 55–60, 80–3, 116–20, 135–7, 315–18, 338–9 (Feb. 10, March 9, June 15, 1936); *Cellulose Ind. 12*, No. 1: 17–21; No. 2: 53–7; No. 3: 81–4 (Jan.–March, 1936). Bibl. at end of each section.

158. Heuser, Emil, The present status of the chemistry of cellulose. *Tappi 35*, No. 11: 481–9 (Nov., 1952); *Bull. Inst. Paper Chem. 23:* 238. 165 references.

159. Hibbert, H., The chemistry of cellulose and wood. *Pulp Paper Can. 34*, No. 2: 100–2 (1933); *Chem. Abstr. 27:* 2801. 62 papers listed.

160. Hibbert, H., and Parsons, J. L., The oxidation of cellulose. *J. Soc. Chem. Ind. 44:* 485T (1924). 58 references.

161. Higgins, S. H., Fibres, textiles, cellulose, and paper. *Repts. Progr. Appl. Chem. 9:* 142–59 (1924). 143 references.

162. Hill, D. W., and Howlett, F., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 29:* 99–122 (1944). 241 references. *30:* 113–37 (1945). 222 references.

163. Hill, E. L., Pulp and paper. *Repts. Progr. Appl. Chem. 32:* 245–57 (1947). 81 references. *33:* 322–37 (1948). 109 references. *34:* 509–23 (1949). 110 references.

164. Hirabayasi, K., Microscopical structure of plant cell wall. *Chem. Rev. (Japan) 6:* 531–45 (1940); *7:* 7–22 (1941). 97 references.

165. Hirst, E. L., and Peat, S., Carbohydrates. *Ann. Repts. Progr. Chem. 33:* 245–66 (1936). 86 references. Starch and Cellulose, p. 256–60.

166. Hochberger, E., Advances in paper sizing in 1929–1934. *Papierfabrik. 33*, No. 7: 49–60 (Feb. 17, 1935). 118 references.

167. Hoff, G. P., Rayon. *Ann. Survey Am. Chem. 4:* 459–66 (1930). 42 references.

168. Howitt, F. O., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 35:* 525–47 (1950).

169. Hubbard, M., Literature of the paper industry. A bibliography adapted from Akesson-Everling-Flückiger. *Paper 21*, No. 23: 54, 56, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80 (Feb. 12, 1919).

170. Hughes, E. B., and Goldenberg, N., Starches. *Repts. Progr. Appl. Chem. 26:* 388–92 (1941). 36 references. *27:* 385–92 (1942). 43 references. *28:* 360–7 (1943). 62 references.

171. Hukuda, Y., Determination of cellulose with chlorine gas. *Chem. Rev. (Japan) 4:* 450–9 (1928). 40 references.

172. Hukuda, Y., Multistage bleaching of pulp. *Chem. Rev. (Japan) 5:* 595–608, 644–61 (1939). 91 references.

173. Hunter, D., Bibliography of marbled paper. *Paper Trade J. 72*, No. 18: 52, 54, 56, 58 (April 28, 1921).

174. Hunter, D., Handmade paper and its watermarks: A bibliography. *Paper 20*, No. 12: 20–6 (May 30, 1917).

175. Hutino, K., X-ray investigations on cellulose fibers. *Chem. Rev. (Japan) 6:* 197–209 (1940). 21 references.

176. Immergut, E. H., and Eirich, F. R., Intrinsic viscosities and molecular weights of cellulose and cellulose derivatives. *Ind. Eng. Chem. 45*, No. 11: 2500–11 (Nov., 1953); *Bull. Inst. Paper Chem. 24:* 287. 72 references.

177. The Institute of Paper Chemistry. Instrumentation studies. XI. Effect of humidity in the physical testing of paper—a survey of the literature. *Paper Trade J. 104*, No. 14: 40–6 (April 8, 1937). About 100 references.

178. The Institute of Paper Chemistry. Instrumentation studies. LI. Penetration of papers by water vapors. V. Methods for measuring vapor and gas permeability—a bibliographical study. *Paper Trade J. 121*, No. 13; 68, 74, 80, 86, 91; No. 16: 33–42 (Sept. 27, Oct. 18, 1945); *Bull. Inst. Paper Chem. 16:* 104.

179. The Institute of Paper Chemistry. The Pratt & Whitney Electrolimit paper gage. Report No. 37 to the American Paper and Pulp Association, Sept. 15, 1942. 18 p. Processed. Bibliography on the determination of thickness and bulk of paper, p. 15–18.

180. The Institute of Paper Chemistry. Sulphite waste liquor—an annotated bibliography. Appleton, Sulphite Pulp Manufacturers' Committee on Waste Disposal, 1940. 617 p. 2485 references.

181. The Institute of Paper Chemistry. United States patents on papermaking, first quarter, 1953. *Tappi 36*, No. 8:164–9A (Aug., 1953); *Bull. Inst. Paper Chem. 24:* 42.

182. The Institute of Paper Chemistry. United States patents on papermaking, second quarter, 1953. *Tappi 36*, No. 11:172–80A (Nov., 1953); *Bull. Inst. Paper Chem. 24:* 303.

183. The Institute of Paper Chemistry. United States patents on papermaking, third quarter, 1953. *Tappi 37*, No. 2: 156–62A (Feb., 1954).

184. Irwin, H. J., Bibliography of corrosion in the pulp and paper industry. *Bull. Inst. Paper Chem. 1*, No. 7: 19–30 (March, 1931). 155 references.

185. Isbell, H. S., and Frush, H. L., Chemistry of the carbohydrates. *Ann. Rev. Biochem. 22:* 107–24 (1953). *Bull. Inst. Paper Chem. 24:* 93. 162 references.

186. Jackson, D. T., and Parsons, J. L., Pulp bleaching. *Tech. Assoc. Papers 22:* 370–6 (June, 1939); *Paper Trade J. 108*, No. 20: 50–6 (May 18, 1939); *Bull. Inst. Paper Chem. 9:* 441. 54 references. *Tech. Assoc. Papers 23:* 256–62 (June, 1940). 72 references.

187. Jahn, E. C., and Holmberg, C. V., Relation of lignin content to the strength of paper and boards. I. Literature survey and progress report. *Tech. Assoc. Papers 23:* 626–31 (June, 1940); *Paper Trade J. 109*, No. 13: 30–5 (Sept. 28, 1939); *Paper Ind. 21*, No. 7: 778, 780 (Oct., 1939); *Bull. Inst. Paper Chem. 10:* 52. 61 references.

188. Jakobson, T., The odor problem of sulphate mills. *Wochbl. Papierfabrik. 69*, No. 38: 777–8; No. 39:796–7 (Sept. 17, 24, 1938). 50 references.

189. Jakobson, T., Tall oil or liquid rosin. A literature review. *Svensk Papperstidn. 42*, No. 18: 473–4; No. 20: 513–14; No. 21: 534–5; No. 23: 600 (Sept. 30, Oct. 31, Nov. 15, Dec. 15, 1939); *43*, No. 2: 24–5; No. 3: 44–5; No. 4: 65–6; No. 6: 109–10; No. 9: 175–9 (Jan. 31, Feb. 15, 29, March 15, 31, May 15, 1940); *46*, No. 6: 128–9; No. 8: 183–6; No. 12: 283–4 (March 31, April 30, June 30, 1943); *47*, No. 19: 473–4; No. 20: 493–4; No. 23: 580–1; No. 24: 605–7 (Oct. 15, 31, Dec. 15, 31, 1944). 378 references.

190. Jakobson, T., Tall oil or liquid rosin; a review of the literature. *Svensk Papperstidn. 52*, No. 11: 290–4; No. 15: 379–82; No. 18: 451–3; No. 19: 481–2 (June 15, Aug. 15, Sept. 30, Oct. 15, 1949); *53*, No. 13: 369–75; No. 15: 444–6 (July 15, Aug. 15, 1950). 317 references.

191. Jakobson, T., Tall oil or liquid rosin—a literature review. *Svensk Papperstidn. 55*, No. 12: 432–8; No. 13: 460–5; No. 14: 483–9 (June 30, July 15, 31, 1952); *Bull. Inst. Paper Chem. 22*: 948. 270 references.

192. Jayme, G., Advances in the field of pulp and paper chemistry. *Chem.-Ztg. 66*, No. 9/10: 89–94 (March 4, 1942); *Bull. Inst. Paper Chem. 13:* 206. 60 references.

193. Jayme, G., Purification of pulps in the light of the patent literature. *Verein Zellstoff-u. Papier-Chemiker u. Ingenieure, Jahresber.* 1936: 80–7; *Papier-Fabr. 35*, No. 1/2: 2–8 (Jan. 8, 1937); *Paper Trade J. 106*, No. 21: 37–42 (May 26, 1938); *Papier 41*, No. 9–10: 735–6, 739–40, 743–4, 747–8 (Sept.–Oct., 1938); *Cellulose Ind. 14*, No. 8: 281–8 (Sept., 1938); *Bull. Inst. Paper Chem. 7:* 238; *Chem. Abstr. 31:* 3266. 60 patent references.

194. Jayme, G., Review of the foreign literature during recent years in the fields of plant, cellulose, pulp, and paper chemistry. *Das Papier 1*, No. 1/2: 3–8; No. 5/6: 83–101 (July, Sept., 1947); *Bull. Inst. Paper Chem. 18:* 128, 450. 176 references.

195. Johnsen, B., and Hovey, R. W., Utilization of waste sulphite liquor. A review of the literature. Canada, Dept. Interior, Forestry Branch, Bull. No. 66: 1919. 195 p.

196. Jones, J. K. N., Carbohydrates. *Ann. Repts. Progr. Chem. 43:* 167–200 (1946). 125 references.

197. Jones, J. K. N., and Smith, F. Plant gums and muci-

lages. *Advances in Carbohydrate Chem. 4:* 243–91 (1949). 167 references.

198. Judd, D. B., Colorimetry of pulp and paper with special reference to "brightness." *Pulp Paper Mag. Can. 43,* No. 2: 94–100 (Feb., 1942); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1942: 54–61; discussion, 61–3; *Bull. Inst. Paper Chem. 12:* 244; *Chem. Abstr. 36:* 2722. 74 references.

199. Kantrowitz, M. S., Spencer, E. W., and Simmons, R. H., Permanence and durability of paper; annotated bibliography of the technical literature from 1885 A.D. to 1939 A.D. *U. S. Govt. Printing Office, Tech. Bull.* No. 22. 1940. 114 p. 290 annotated references.

200. Kasbekar, G. S., Swelling of cellulose in solutions of acids. *Indian Pulp and Paper 4,* No. 8: 313–15 (Feb., 1950); *Bull. Inst. Paper Chem. 20:* 670. 56 references.

201. Kasbekar, G. S., Swelling of cellulose in solutions of neutral salts—an historical review. *Indian Pulp and Paper 3,* No. 6: 237–41 (Dec., 1948); *Bull. Inst. Paper Chem. 19:* 589. 62 references.

202. Kasbekar, G. S., Swelling of cellulose in solutions of neutral salts—x-ray evidence and theories of swelling. *Indian Pulp and Paper 3,* No. 9: 347–50 (March, 1949); *Bull. Inst. Paper Chem. 19:* 809. 60 references.

203. Kenner, J., Jones, D. W., and Sharples, A., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 37:* 723–43 (1952). 201 references.

204. Kenney, A. W., Survey of the literature on cellulose and allied substances. V. The structure of cellulose and its derivatives by the x-ray diffraction method. *Tech. Assoc. Papers 25:* 722–3 (June, 1942). 17 references.

205. King, A. T., Textiles, fibres, and cellulose. *Repts. Progr. Appl. Chem. 19:* 153–76 (1934). 147 references.

206. Kirby, R. H., Long vegetable fibres—production. *Rev. Textile Progr. 2:* 113–30 (1950). 55 references. *3:* 152–84 (1951). 102 references.

207. Klein, L., Sewage, rivers pollution, and trade wastes. *Repts. Progr. Appl. Chem. 34:* 810–35 (1949). 164 references.

208. Korn, R., Advances in pulp and paper testing. 1935. *Wochbl. Papierfabrik. 67,* No. 16: 296–8 (April 18, 1936); *Zellstoff u. Papier 16,* No. 5: 173–6 (May, 1936); *Papier-Fabr. 34,* No. 18: 137–40 (May 3, 1936); *Tech. Bull. Tech. Sect., Brit. Paper and Board Makers' Assoc. 13,* No. 6: 83–4; No. 7: 96; No. 8: 110 (June, July, Aug., 1936). 42 references. 1936. *Zellstoff u. Papier 17,* No. 6: 233–7 (June, 1937); *Papier-Fabr. 35,* No. 22: 188–92 (May 28, 1937); *Wochbl. Papierfabrik. 68,* No. 21: 395–7; No. 22: 412–13 (May 22, 29, 1937); *Papeterie 59,* No. 18: 850, 853–4, 857; No. 19: 894, 897–8 (Sept. 25, Oct. 10, 1937); *Tech. Bull. Tech. Sect., Brit. Paper and Board Makers' Assoc. 14,* No. 9: 121–2; No. 10: 130; No. 11: 149–50 (Sept., Oct., Nov., 1937); *Industria carta (Milan) 4,* No. 9: 329–32 (Sept., 1937). 41 references. *1937. Zellstoff u. Papier 18,* No. 7: 400–4 (July, 1938); *Papier-Fabr. 36,* No. 26: 304–8 (June 24, 1938); *Wochbl. Papierfabrik. 69,* No. 26: 550–2; No. 27: 569–70 (June 25, July 2, 1938); *Cellulose Ind. 14,* No. 9: 328–33 (Sept., 1938); *Tech. Bull. Tech. Sect., Brit. Paper and Board Makers' Assoc. 15,* No. 8: 109–10; No. 9: 131–2; No. 10: 148–9; No. 11: 156 (1938); *Industria carta (Milan) 5,* No. 11: 411–12 (Nov., 1938). 47 references. *1938–1939. Wochbl. Papierfabrik. 71,* No. 27: 335–8; No. 28: 349–51 (July 6, 13, 1940); *Papier-Fabr. 38:* 162–4, 168–71 (1940); *Zellstoff u. Papier 20,* No. 7: 207–10; No. 8: 235–8 (July, Aug., 1940). 93 references.

209. Korte, H., and Kaufmann, W., The bleaching with sodium chlorite. *Melliand Textilber 23,* No, 5: 234–9 (May, 1942). 29 references.

210. Kraemer, E. O., Survey of the literature on cellulose and allied substances—1938–1940. II. Colloidal aspects of cellulose. *Tech. Assoc. Papers 25:* 711–16 (June, 1942). 314 references.

211. Kraemer, J. H., Wood conservation—bibliography. U. S. Dept. Commerce, Office of Industry and Commerce, Domestic Commerce Series No. 30. Washington, D. C., Govt. Print. Off., 1952. 77 p. Contains references on the utilization of wood waste.

212. Kratky, O., The micellar structure of cellulose and its derivatives. *Angew. Chem. 53,* No. 15/16: 153–62 (April 13, 1940); *Bull. Inst. Paper Chem. 10:* 410. 75 references.

213. Kratky, O., Size and shape of micelles in regenerated cellulose. *Holz Roh- u. Werkstoff 11,* No. 7: 263–7 (July, 1953); *Bull. Inst. Paper Chem. 24:* 407. 31 references.

214. Kratzl, K., The qualitative determination of lignification. *Holz Roh- u. Werkstoff 11,* No. 7: 269–76 (July, 1953); *Bull. Inst. Paper Chem. 24:* 359. 65 references.

215. Krses, C., and Moss, L. A., Survey of pitch troubles in the manufacture and use of sulphite pulp. *Tech. Assoc. Papers 19:* 186–97 (June, 1936); *Paper Trade J. 102,* No. 25: 38–9 (June 18, 1936); *Bull. Inst. Paper Chem. 6:* 438; *Chem. Abstr. 30:* 7334. 103 references.

216. Krüger, D., Advances in cellulose chemistry. *Zellstoff u. Papier 15,* No. 2: 51–2; No. 3: 89–92 (Feb., March, 1935). 78 references.

217. Kr üger, D., The chemistry of cellulose in 1933. *Zellstoff u. Papier 14,* No. 3: 89–93 (March, 1934); *Chem. Abstr. 28:* 2891. 53 references.

218. Krüger, D., The development of organic chemistry, especially the chemistry of cellulose and pulp, in 1931. *Zellstoff u. Papier 12,* No. 2: 57–62 (Feb., 1932); *Chem. Abstr. 26:* 4467. 77 references.

219. Krüger, D., The structure of wood and cellulose fiber. *Zellstoff u. Papier 17,* No. 1: 10–13 (Jan. 1937); *Bull. Inst. Paper Chem. 7:* 178. 55 references.

220. Kürschner, K., Chemistry of lignin bodies. *Paper Trade J. 86,* No. 16: 62–71 (April 19, 1928); *Tech. Assoc. Papers 11,* No. 1: 100–9; discussion, 226–7 (June, 1928); *Paper Makers' Monthly J. 66,* No. 10: 458–61, 463; No. 11: 496–500; No. 12: 535–9 (Oct., Nov., Dec., 1928). 181 references.

221. Kukolich, S. I., Bibliography of pitch troubles, causes and possible remedies. *Bull. Inst. Paper Chem. 3,* No. 2: 41–51 (Oct. 1932).

222. Kurth, E. F., The chemical composition of barks. *Chem. Revs. 40,* No. 1: 33–49 (Feb., 1947); *Bull. Inst. Paper Chem. 17:* 405. 83 references.

223. Landes, C. G., TAPPI survey of paper coating literature. 1945. *Tech. Assoc. Papers 29:* 359–64 (June, 1946); *Paper Trade J. 123,* No. 7: 39–44 (Aug. 15, 1946). 142 references. *1946. Tappi 32,* No. 3: 121–8 (March, 1949).

224. Larocque, G. L., Developments in pulp and paper testing. 1940. *Pulp Paper Mag. Can. 42,* No. 2: 84–7 (Feb., 1941); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1941: 16–20; *Bull. Inst. Paper Chem. 11:* 252. 92 references. 1941. *Pulp Paper Mag. Can. 43,* No. 2: 174, 199–201 (Feb., 1942); *Proc. Tech. Sect., Can Pulp Paper Assoc.* 1942: 30–4. 100 references.

225. Laughlin, E. R., Permanence and durability of paper. *Bull. Inst. Paper Chem. 1,* No. 8: 19–30 (April, 1931). 160 references.

226. Leibowitz, J., Present status of the chemistry of disaccharides and trisaccharides. *Cellulosechemie 9,* No. 12: 125–34 (Dec. 2, 1928). 99 references.

227. Lewis, H. F., Cellulose and paper. *Ann. Survey Am. Chem. 6:* 487–506 (1932). 7 references. *8:* 279–93 (1934); *10:* 359–77 (1936). 240 references. *Paper Trade J. 99,* No. 5: 31–7 (Aug. 2, 1934). 168 references.

228. Lewis, H. F., A survey of the American literature in the field of cellulose and related subjects for 1933 through 1937. *Paper Trade J. 107,* No. 21: 40–8; No. 23: 31–6; No. 24: 31–9 (Nov. 24, Dec. 8, 15, 1938); *Bull. Inst. Paper Chem. 9:* 189. 475 references.

229. Lewis, H. F., Survey of the literature on cellulose and allied substances—1938–1940. VII. Cellulose and allied substances in the field of pulp and paper. *Tech. Assoc. Papers 25:* 724–33 (June, 1942). 244 references.

230. Lewis, H. F., Ten years of fundamental research in the pulp, paper, and paperboard industry. *Tech. Assoc. Papers 25:* 436–40 (June, 1942); *Paper Trade J. 115,* No. 27: 32–6 (Dec. 31, 1942); *Bull. Inst. Paper Chem. 13:* 160; *Chem. Abstr. 36:* 7315.

231. Libby, C. E., Pulp and paper making. New York State College of Forestry, Syracuse, N. Y. 800 entries by author, title, and subject. 1914–1922. Brief abstracts.

232. Liebert, E., Technical developments in the pulp, mechanical pulp and paper industry. 1937. *Zellstoff u. Papier 18,* No. 2: 53–5; No. 3: 116–21 (Feb., March, 1938). 69 references. *1938. Zellstoff u. Papier 19,* No. 1: 13–15; No. 2: 65–9 (Jan., Feb., 1939). 73 references.

233. Litkenhous, E. E., Bagasse as a source of pulp. WPB Project 134. 51 p. and 47 unnumbered pages of bibliography. July 31, 1944. Processed. Abstract in *Chemurgic Dig. 4.* No. 10: 169, 171–8 (May 31, 1945); *Bull. Inst. Paper Chem. 15:* 399.

234. Ljunggren, B., The bleaching of groundwood pulp with peroxide. A literature and patent review. *Svensk Papperstidn.* 50, No. 7: 159–68; No. 8: 196–204 (April 15, 30, 1947); *Bull. Inst. Paper Chem. 17:* 612; *Chem. Abstr. 41:* 6401. 45 references.

235. Lladó, J., Lignin—a new material of prime importance to industry. Its chemical properties and industrial applications. *Afinidad 22:* 117–21, 179–83, 210–23 (1945); *Chem. Abstr. 42:* 5660. 127 references.

236. Love, S. K., Water analysis (review). *Anal. Chem. 23,* No. 2: 253–7 (Feb., 1951). 101 references.

237. Lutz, A., Bibliography of pulp and paper manufacture. (Mechanical part): 1909. *Wochbl. Papierfabrik. 40,* No. 15: 1186–8; No. 16: 1262–6; No. 37: 3142–4; No. 38: 3217–21; No. 39: 3297–9 (1909); *41,* No. 19: 1589–91; No. 20: 1702–5; No. 21: 1774–6; No. 47: 4227–8; No. 49: 4418–21; No. 50: 4518–20; No. 51: 4603–9 (1910). *Papier-Ztg. 34,* No. 32: 1236–7; No. 33: 1271–2; No. 34: 1316–17; No. 78: 3015–16; No. 79: 3051–2; No. 80: 3095–6; No. 82: 3175–6 (1909); *35,* No. 43: 1625–6; No. 44: 1662–3; No. 45: 1700–1; No. 92: 3478; No. 93: 3515–16; No. 95: 3595–6; No. 96: 3631–3; No. 97: 3667 (1910). *1910. Wochbl. Papierfabrik. 43,* No. 12: 994–9; No. 13: 1090–1; No. 14: 1178–82; No. 16: 1348–51; No. 20: 1786–9; No. 22: 1983–5; No. 26: 2495–7; No. 32: 3073–5; No. 34: 3258–60; No. 38: 3610–12

(1913). *Papier-Ztg. 37*, No. 27: 995–7; No. 28: 1031–2; No. 30: 1098–1100; No. 31: 1136; No. 34: 1242–4; No. 95: 3427–9; No. 97: 3507–8; No. 98: 3539–41; No. 99: 3579–80; No. 100: 3611–12; No. 102: 3679–80 (1912). *1911. Wochbl. Papierfabrik. 46*, No. 21: 945–7; No. 23: 1036–7; No. 25: 1132–6; No. 26: 1171–4; No. 28: 1263–6; No. 29: 1312–13; No. 30: 1350–3; No. 31: 1389–91; No. 32: 1431–3; No. 33: 1489–91; No. 34: 1526–7; No. 36: 1615–16; No. 37: 1668–9; No. 38: 1713–15; No. 39: 1757–9 (1915). *Papier-Ztg. 40*, No. 39: 818–20; No. 43: 890–2, No. 47: 959–60; No. 48: 978; No. 49: 995–6; No. 50: 1012–13; No. 51: 1028–9; No. 52: 1044–5; No. 53: 1061–2; No. 57: 1132–4; No. 58: 1152–3; No. 59: 1168–9; No. 60: 1188–9 (1915).

238. Lydenburg, H. M., Bibliography of paper deterioration. *Paper 22*, No. 19: 12–13 (July 17, 1918).

239. McCarthy, J. L., Recent developments in the production of ethanol from waste sulphite liquor and wood. *Pulp Paper Mag. Can. 43*, No. 2: 205–6, 208, 210, 212, 214 (Feb., 1942); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1942: 39–45; *Bull. Inst. Paper Chem. 12:* 237. 99 references.

240. Marchionna, F., Latex and rubber derivatives and their industrial applications. A bibliography of patents and published literature. June, 1932—January, 1937. Vol. II and III. New York, Rubber Age, 1937. 1670 p. Paper and artificial leather manufacture, p. 536–622. 230 references.

241. Mark, H., Intermicellar hole and tube system in fiber structure, *J. Phys. Chem. 44*, No. 6: 764–88 (June, 1940); *Bull. Inst. Paper Chem. 10:* 410; *Chem. Abstr. 34:* 5655. 118 references.

242. Mark, H., Relation between chain length distribution curve and tenacity. *Tech. Assoc. Papers 24:* 217–23 (June, 1941); *Paper Trade J. 113*, No. 3: 34–40 (July 17, 1941); *Rayon Textile Monthly 22*, No. 7: 409–10 (July, 1941); *Textile Colourist 63*, No. 751: 435 (July, 1941); *Bull. Inst. Paper Chem. 11:* 440; *Chem. Abstr. 35:* 6439; *Brit. Chem. Physiol. Abstr.* 1941B, II: 425. 48 references.

243. Mark, H., Some advances in the chemistry of cellulose. *Holz Roh- u. Werkstoff 11*, No. 7: 257–60 (July, 1953). 22 references.

244. Mark, H., X-ray investigations of carbohydrates. *Chem. Revs. 26*, No. 2: 169–86 (April, 1940); *Bull. Inst. Paper Chem. 10:* 363. 55 references.

245. Mark, H., and Simha, R., Viscosity and molecular structure. *Nature 145*, No. 3676: 571–3; *146*, No. 3692: 167–8 (April 13, Aug. 3, 1940); *Bull. Inst. Paper Chem. 10:* 388; 11: 89. 36 references.

246. Marsden, R. J. B., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 24:* 157–79 (1939). 171 references. *25:* 145–57 (1940). 116 references.

247. Marsh, J. T., and Wood, F. C., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 26:* 117–38 (1941). 176 references. *27:* 121–42 (1942). 170 references.

248. Marshall, H. B., The utilization of waste sulphite liquor—a bibliography of the literature published during 1950. *Pulp Paper Mag. Can. 52*, No. 2: 61–8 (Feb., 1951). 70 references.

249. Marshall, H. B., The utilization of waste sulphite liquor—a bibliography of the literature published during 1951. *Pulp Paper Mag. Can. 53*, No. 5: 125–37 (April, 1952). 152 references.

250. Marshall, H. B., and Johnson, A. M., Utilization of waste sulphite liquor. A bibliography of the literature from July, 1943 to December, 1949. Toronto, Research Council of Ontario, 1950. 103 p.

251. Marshall, H. B., and Johnson, A. M., Utilization of sulphite waste liquor—a bibliography of the literature from July, 1943 to December, 1950. *Tappi* 35, No. 1: 146–80A (Jan., 1952).

252. Marshall, H. B., and Neate, J. M., The utilization of sulphite waste liquor—bibliography of literature published during 1952. Parts I and II. *Pulp Paper Mag. Can. 54*, No. 7: 125–35; No. 9: 113–26 (June, Aug., 1953); *Tappi 37*, No. 1: 156–76A (Jan., 1954); *Bull. Inst. Paper Chem. 24:* 144.

253. Marshall, W. R., Jr., Drying. *Ind. Eng. Chem. 45*, No. 1: 47–54 (Jan., 1953); *Bull. Inst. Paper Chem. 23:* 403. 232 references.

254. Maynard, C. R. G., Literature survey of the effect of loading materials on the properties of paper and of pulp suspensions. *Paper-Maker (London) 123*, No. 4: 312, 314, 316, 318–20, 322; No. 5: 402–4, 406–9 (April, May, 1952); *Bull. Inst. Paper Chem. 22:* 757. 108 references.

255. Meeuse, A. D. J., Development and growth of the sclerenchyma fibers and some remarks on the development of the tracheids in some monocotyledons. *Rev. trav. botan. neerland. 35:* 288–414 (1938); *Chem. Abstr. 33:* 686. 136 references.

256. Meredith, R., Cotton and cellulose—physics. *Rev. Textile Progr. 1:* 7–13 (1949). 35 references. *2:* 7–15 (1950). 35 references. *3:* 7–18 (1951). 46 references.

257. Merrill, R. C., Sodium silicates in the paper industry. *Tappi 32*, No. 11: 520–8(Nov., 1949); *Bull. Inst. Paper Chem. 20:* 271. 97 references.

258. Meyer, H. H. B., Paper manufacture: A bibliography. *Paper Trade J. 72*, No. 13: 56, 58, 60, 62, 64, 66; No. 14: 50, 52, 54, 56, 58; No. 15: 48, 50, 52, 54, 56, 58, 60 (March 24, 31, April 7, 1921).

259. Meyer, K. H., The past and present of starch chemistry. *Experientia 8*, No. 11: 405–20 (Nov., 1952); *Bull. Inst. Paper Chem. 23:* 358. 182 references.

260. Micheel, F., Recent results of carbohydrate chemistry. *Angew. Chem. 52*, No. 1: 6–17 (Jan. 7, 1939). Includes cellulose, hemicelluloses, etc. 135 references.

261. Michel-Jaffard, R., Present status of our knowledge of the intimate structure of cellulose fibers. *Chimie & industrie 19:* 801–8, 1003–12 (May, June, 1928); *Papier 31*, No. 8: 831–4, 837–41; No. 9: 945–8, 951–2; No. 10: 1057–63 (Aug., Sept., Oct., 1928); *Boll. staz. sper. ind. carta 7*, No. 12: 139–42 (Dec., 1928). 53 references.

262. Miller, L. B., TAPPI survey of progress in water technology. 1939. *Paper Trade J. 110*, No. 20: 38–41 (May 16. 1940); *Tech. Assoc. Papers 23:* 110–13 (June, 1940); *Bull. Inst, Paper Chem. 10:* 402; *Chem. Abstr. 34:* 6070. *1940. Tech. Assoc, Papers 24:* 447–59 (June, 1941); *Paper Ind. 23*, No. 4: 396–8, 400, 402 (July, 1941); *Bull. Inst. Paper Chem. 12:* 129. 324 references. *1941. Tech. Assoc. Papers 25:* 281–7 (June, 1942); *Paper Trade J. 114*, No. 16: 38–44 (April 16, 1942); *Bull. Inst. Paper Chem. 12:* 301. 225 references. *1942. Tech. Assoc. Papers 26:* 99–108 (June, 1943); *Paper Trade J. 116*, No. 16: 25–34 (April 22, 1943); *Tech. Paper* No. 86, W. H. & L. D. Betz, Philadelphia, Pa.; *Bull. Inst. Paper Chem. 13:* 380; *Chem. Abstr. 37:* 3862. 270 references. *1943. Tech. Assoc. Papers 27:* 239–49 (June, 1944); *Paper Trade J. 119*, No. 24: 38–48 (Dec. 14, 1944); *Bull. Inst. Paper Chem. 15:* 190. 250 references.

263. Miller, S. A., Filtration. *Ind. Eng. Chem. 39*, No. 1: 5–7 31–2 (Jan., 1947). 139 references. *40*, No. 1: 25–7 (Jan., 1948). 73 references. *41*, No. 1: 38–41 (Jan., 1949). 72 references. *42*, No. 1: 52–5 (Jan., 1950). 100 references. *43*, No. 1: 85–9 (Jan., 1951). 151 references. *44*, No. 1: 63–8 (Jan., 1952). 172 references. *45*, No. 1: 68–73 (Jan., 1953). 221 references.

264. Moore, W. F., Bibliography of wood pulp strength testing. *Paper Trade J. 89*, No. 12: 62–72 (Sept. 19, 1929). 63 references with abstracts.

265. Moosdorf, W., Collected literature on chemistry of cellulose and paper and pulp manufacture appearing in German journals from Oct. 1, 1927 to March 31, 1928. *Tech. Chem. Papier- u. Zellstoff-Fabr. 25*, No. 4: 52–9 (April 28, 1928). 64 references. April 1 to Dec. 31, 1928. *Ibid, 26*, No. 6: 96–102; No. 7: 113–20 (June 29, Aug. 3, 1929). 161 references. Jan. 1 to June 30, 1929. *Ibid. 27*, No. 2/3: 37–43; No. 5:71–6; No. 6: 88–95 (March 29, May 31, July 12, 1930). 217 references. July 1 to Dec. 31, 1929. *Ibid. 27*, No. 11/12: 153–66 (Nov. 29, 1930). 215 references.

266. Mory, H., Technical developments of pulp, mechanical pulp, and paper. 1935. *Zellstoff u. Papier 16*, No. 7: 270–3; No. 8: 341–3 (July, Aug., 1936). 54 references. *1936. Zellstoff u. Papier 17*, No. 3: 97–102; No. 4: 157–8; No. 5: 193–6 (March, April, May, 1937); *Paper-Maker (London) 93*, No. 6: TS85–8 (June, 1936); *Bull. Inst. Paper Chem. 7:* 378. 53 references.

267. Motigny, R. de., Review of testing methods. *Pulp Paper Mag. Can. 45*, No. 3: 198–201 (Feb., 1944); *Proc. Tech. Sect., Can. Pulp Paper Assoc. 1944:* 37–40. 64 references.

268. Müller, M., Recent developments in sulphite waste liquor disposal. *Wochbl. Papierfabrik. 44*, No. 24: 2206–9; No. 47: 4429–32; No. 48: 4504–7; No. 49: 4619–21; No. 50: 4690–1; No. 51: 4801–2; No. 52: 4871–4 (1913); *45*, No. 1: 23–5; No. 2: 96–9; No. 3: 194–6; No. 4: 272–3; No. 5: 371–3; No. 6: 457–60 (1914). Reprinted with the title: Literatur der Sulfitablauge. Berlin, 1914. 114 p. 450 references.

269. Munns, E. N., A selected bibliography of North American forestry. U. S. Dept. Agr., Misc. Publ. No. 364. 2 v. 1940. 1142 p.

270. Myllynen, R., and Davis, D. S., Bibliography of nomographs of pulp and paper applications. *Paper Ind. 23*, No. 11: 1089, 1092 (Feb., 1942); *Bull. Inst. Paper Chem. 12:* 215.

271. Myrbäck, K., Products of the enzymic degradation of starch and glycogen. *Advances in Carbohydrate Chem. 3:* 251–310 (1948). 107 references.

272. Napper, S. S., Fibres, textiles, cellulose and paper. *Repts. Progr. Appl. Chem. 4:* 114–36 (1919). 132 references. *5:* 125–49 (1920). 143 references.

273. National Southern Products Corp. A bibliography with abstracts on tall oil in the paint, varnish, lacquer, core oil, ink, and related industries. Bull. No. 7. New York, N. Y. The Corporation, n.d. 8 p. *Tappi 33*, No. 1: 76–82A (Jan., 1950).

274. National Southern Products Corp. A bibliography with abstracts on tall oil in the soap, detergent, sulfonating, emulsifying and related industry. Bull. No. 8. New York, N. Y. The Corporation, n.d. 20 p. *Tappi 33*, No. 2: 58A, 60A, 62A, 64A, 66A, 68A, 70–80A (Feb., 1950).

275. Neale, S. M., Cellulose and textile chemistry. *Repts. Progr. Appl. Chem. 33:* 309–21 (1948). 78 references.

276. Neale, S. M., Cotton and cellulose—chemistry. *Rev. Textile Progr. 1:* 14–23 (1949). 46 references. *2:* 16–22 (1950). 53 references.

277. Nevell, T. P., Cotton and cellulose—chemistry. *Rev. Textile Progr. 3:* 19–43 (1951). 119 references.

278. Newns, A. C., The methods of determining the water vapor permeability of laminae: a review of the literature. *J. Textile Inst. 41*, No. 8: T269–308 (Aug., 1950); *Bull. Inst. Paper Chem. 21:* 106. 164 references.

279. Nickerson, R. F., Cotton fibers. *Ind. Eng. Chem. 32*, No. 11: 1454–62 (Nov., 1940); *Bull. Inst. Paper Chem. 11:* 122; *Chem. Abstr. 35:* 907. 133 references.

280. Nickerson, R. F., The relative crystallinity of celluloses. *Advances in Carbohydrate Chem. 5:* 103–26 (1940). 40 references.

281. Norman, A. G., Chemistry of the carbohydrates and glycosides. *Ann. Rev. Biochem. 10:* 65–90 (1941); *Bull. Inst. Paper Chem. 11:* 395. 118 references.

282. Norman, D. J., Fibres, textiles, cellulose, and paper. *Repts. Progr. Appl. Chem. 10:* 137–64 (1925). 183 references. *11:* 117–43 (1926). 185 references. *12:* 120–43 (1927). 161 references.

283. Obermans, H. E., Bibliography of the effect of hydration and dryer temperature on sizing. *Bull. Inst. Paper Chem. 1*, No. 10: 23–9 (June, 1931). 29 references.

284. O'Dwyer, M. H., Recent advances in the study of the chemistry of the hemicelluloses of wood. *J. Soc. Chem. Ind. (Chemistry and Industry) 51*, No. 48: 968–71 (Nov. 25, 1932); *Chem. Abstr. 27:* 596. 35 references.

285. Ostertag, H., Cellulose decompositon by bacteria. *Ergebn. Hyg. Bakteriol. Immunitätsforsch. u. Exptl. Therap. 27:* 149–322 (1952). *Bull. Inst. Paper Chem. 23:* 708. Extensive bibliography.

286. Owen, L. N., Carbohydrates. *Ann. Repts. Progr. Chem. 40:* 109–22(1943). 100 references.

287. Paine, F. A., The permeability of organic membranes to gases and vapours—a review of the literature. Patra Packaging Research Report, No. 1. London, PATRA, 1947. 36 p. *Bull. Inst. Paper Chem. 17:* 643.

288. Parsons, H. L., Bast fibres—physics and chemistry. *Rev. Textile Progr. 3:* 44–61 (1951); *Bull. Inst. Paper Chem. 23:* 553. 117 references.

289. Parsons, J. L., and Tongren, J. C., Pulp bleaching. 1939–1940. *Tech. Assoc. Papers 24:* 463–69 (1941); *Paper Trade J. 112*, No. 22: 50–6 (May 29, 1941); *Bull. Inst. Paper Chem. 11:* 347. 70 references. 1940–1941. *Tech. Assoc. Papers 25:* 470–4 (June, 1942); *Paper Trade J. 115*, No. 8: 36–40 (Aug. 20, 1942). 55 references.

290. Papyras, G., The action of metallic hydroxides on cellulose. *Rev. gen. mat. plastiques 2:* 759–71 (1926); *3:* 3–15 (1927). 86 references.

291. Peat, S., Carbohydrates. *Ann. Repts. Progr. Chem. 36:* 258–78 (1939). Starch and cellulose, p. 271–8. 55 references. *34:* 286–302 (1937). 46 references.

292. Peat, S., Polysaccharides. *Ann. Repts. Progr. Chem. 38:* 150–70 (1941). 71 references.

293. Percival, E. G. V., The lignin problem. *Ann. Repts. Progr. Chem.* 1942: 142–55 (1943); *Pulp Paper Mag. Can. 45*, No. 1: 17–23 (Jan., 1944). 83 references.

294. Perila, O., The effect of cooking conditions of dissolving-grade sulfite pulps from birch on their suitability for the manufacture of viscose. *Paper and Timber (Finland) 35*, No. 4a: 139–52, 154 (Special issue, April, 1953); *Bull. Inst. Paper Chem. 24:* 49. 69 references.

295. Perlman, D., Brown, W. E., and Lee, S. B., Fermentation. *Ind. Eng. Chem. 43*, No. 9: 1996–2012 (Sept., 1952); *Bull. Inst. Paper Chem. 23:* 96. Includes spent sulphite liquor. 446 references.

296. Peterson, F. C., and Hamer, P. L., Paper. *Ann. Survey Am. Chem. 5:* 496–506 (1931). 74 references.

297. Philippoff, W., Importance of viscosity in the chemistry of cellulose. *Cellulosechemie 17*, No. 7/8: 57–77 (July 5, 1936); *Bull. Inst. Paper Chem. 7:* 6; *Chem. Abstr. 30:* 8601. 144 references.

298. Phillips, M., The chemistry of lignin. *Chem. Revs. 14*, No. 1: 103–70 (Feb., 1934). 304 references.

299. Plapper, J., New findings in the chemistry of lignins and lignosulphonic acids. *Colloquiumsber. Insts. Gerbereichemie. tech. Hochschule Darmstadt* No. 5: 60–79 (1949). 50 references.

300. Poggi, A. P., Lignin problem. *Chimica (Milan) 4:* 221–30, 267–73 (1949); *Chem. Abstr. 43:* 9438. 99 references.

301. Potter, G. J. C., A bibliographical study of the influence of the sodium sulphide content of cooking liquors in the sulphate process. *Forest Products Labs. Can., Pulp Paper Lab., Quart. Rev.*, No. 15: 1–6 (July-Sept., 1933). Mimeographed.

302. Potter, G. J. C., Review of the literature on the sulphite process. 1943-Aug., 1945. *Pulp Paper Mag. Can. 47*, No. 3: 280–2, 284 (Feb., 1946); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1946: 40–3; *Paper Ind. 27*, No. 11: 1715–18 (Feb., 1946); *Bull. Inst. Paper Chem. 16:* 415; *Chem. Abstr. 40:* 4516. 38 references. *Aug., 1945-Aug., 1946, Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1947: 31–4; *Pulp Paper Mag. Can. 48*, No. 3: 249–50, 295–6 (Feb., 1947); *Bull. Inst. Paper Chem. 17:* 524. 30 references. *Sept., 1946-Aug., 1947. Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1948: 29–31; *Pulp Paper Mag. Can. 49*, No. 3: 316, 318, 320 (Feb., 1948); *Bull. Inst. Paper Chem. 18:* 553. 22 references. *Aug., 1947-Aug., 1948. Pulp Paper Mag. Can. 50*, No. 3: 312, 314, 316–18 (Feb., 1949); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1949: 33–6; *Bull. Inst. Paper Chem. 19:* 589. 29 references. *Sept., 1948-Aug., 1949. Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1950: 193–6; *Pulp Paper Mag. Can. 51*, No. 3: 300, 302, 304, 306 (Feb., 1950); *Bull. Inst. Paper Chem. 20:* 594. 32 references.

303. Potter, G. J. C., Review of the literature on the sulphite process. Sept., 1949-Aug., 1950. *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1951: 227–31; *Pulp Paper Mag. Can. 52*, No. 5: 82–5, 88 (April, 1951); *Bull. Inst. Paper Chem. 21:* 732. 36 references.

304. Potter, G. J. C., A review of the literature on the sulphite process from September, 1950 to August, 1951. *Proc. Tech. Sect., Can Pulp Paper Assoc.*, 1952: 321–5; *Bull. Inst. Paper Chem. 23:* 441; *Chem. Abstr. 47:* 1931. 45 references.

305. Potter, G. J. C., and Yorston, F. H., Advances in the chemistry of wood, 1939–1940. *Pulp Paper Mag. Can. 42*, No. 2: 88–91 (Feb., 1941); *Proc. Tech. Sect., Can Pulp Paper Assoc.* 1941: 21–3; *Bull. Inst. Paper Chem. 11:* 253. 54 references.

306. Potter, G. J. C., and Yorston, F. H., The pulping of hardwoods by the sulphite process. I. A survey of the literature. *Pulp Paper Mag. Can. 38*, No. 2: 103–8 (Feb., 1937); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1937: 57–62. 28 references.

307. Potts, T. T., Pulp and paper. *Repts. Progr. Appl. Chem. 23:* 238–51 (1938). 95 references.

308. Pozin, M. E., Methods of production, properties, and uses of calcium hypochlorite. *J. Chem. Ind. (Moscow) 13:* 672–8 (1936). 197 references.

309. Preston, J. M., Turner, H. A., and Wall, C. L., Cellulose textile materials. Properties, manufacture, and chemical processing. *Repts. Progr. Appl. Chem. 23:* 196–237 (1938). 230 references.

310. Purves, C. B., Cellulose esters and ethers. *Tech. Assoc. Papers 25:* 718–22 (1942). 116 references.

311. Radley, J. A., The oxidation of starch. *Mfg. Chemist 13*, No. 5: 101–5; No. 7: 158–61, 166; No. 8: 201–3 (May, July, Aug., 1942). 242 references.

312. Rance, H. F., Progress in pulp and paper technology during 1952. *Paper-Maker (London) 126*, No. 1: 34, 37–40, 42–4 (July, 1953); *Bull. Inst. Paper Chem. 24:* 41. 83 references.

313. Rance, H. F., Pulp and paper. *Repts. Progr. Appl. Chem. 37:* 703–22 (1952). 183 references.

314. Rassow, B., and Wagner, K., Lignin of pine wood. *Wochbl. Papierfabrik. 63*, No. 6: 103–6; No. 9: 161–4; No. 13: 243–6; No. 16: 303–5; No. 18: 342–4 (Feb. 6, 27, March 26, April 16, 30, 1932); *Chem. Abstr. 26:* 6132. About 100 references.

315. Rauchberg, H., Recent advances in bleaching. *Papier-Fabr. 34*, No. 14: 109–11; No. 15: 117–19; No. 16: 121–7 (April 5–19, 1936); *Cellulose Ind. 12*, No. 10: 297–309 (Oct., 1936); *Paper Ind. 18:* 137, 139, 227, 229, 231; *Bull. Inst. Paper Chem. 6:* 391. 120 references.

316. Reichert, J. S., and Pete, R. H., Peroxide bleaching of groundwood. Recent developments and commercial status. *Tappi 32*, No. 3: 97–107 (March, 1949); *Pulp Paper Mag. Can. 50*, No. 5: 103–12 (April, 1949); *Paper Mill News 72*, No. 21: 36–40, 42, 45–6, 72 (May 21, 1949); *Bull. Inst. Paper Chem. 19:* 532; *Chem. Abstr. 43:* 3614; *Brit. Abstr.* 1949B, II: 890. 60 references.

317. Reid, E. E., Esterification. *Ind. Eng. Chem. 45*, No. 9: 1936–43 (Sept., 1953); *Bull. Paper Inst. Chem. 24:* 95. 284 references.

318. Review of research and development in the field of textiles. *Textile Research J. 20*, No. 5: 317–60 (May, 1950). 826 references. Classified. Chemistry of cellulose and cellulose derivatives, p. 344–6; structure and properties of cellulose fibers, p. 347–8.

319. Risi, J., Chemical utilization of wood. *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1946: 268–75; *Pulp Paper Mag. Can. 46.*, No. 8: 611–18 (July, 1945); *Bull. Inst. Paper Chem. 16:* 170. About 200 references.

320. Ritter, G. J., The morphology of cellulose fibers as related to the manufacture of paper. *Tech. Assoc. Papers 19:* 435–43 (June, 1936); *Paper Trade J. 101*, No. 18: 92–100 (Oct. 31, 1935). 24 references.

321. Rochow, T. G., and Stafford, R. W., Coatings. *Anal. Chem. 23*, No. 2: 212–16 (Feb., 1951); *Bull. Inst. Paper Chem. 21:* 490. 164 references.

322. Rochow, T. G., and Stafford, R. W., Coatings. *Anal. Chem. 24*, No. 2: 232–7 (Feb., 1952); *Bull. Inst. Paper Chem. 22:* 523; *Packaging Abstr. 9:* 300. 158 references.

323. Rogovin, Z. S., Micellic structure of cellulose. *Org. Chem. Ind. (U.S.S.R.) 2:* 645–8 (1936). 40 references.

324. Roi, J., Bibliography of bamboo. *Peking Natl. Hist. Bull. 16*, No. 1: 1–16 (1941).

325. Rollins, M. L., Fort, H. H., and Skau, D. B., Cellulose-water relations: a selected bibliography with special reference to swelling of cotton and to its utilization in water-resistant fabrics. U. S. Department of Agriculture, Library List No. 44. 1949. 63 p. 53 references. Annotated.

326. Rose, L., Rayon and other manufactured fibers—production. *Rev. Textile Progr. 2:* 136–51 (1950). 94 references. *3:* 194–206 (1951). 93 references.

327. Rossman, J., The electrodeposition of cellulose. *Cellulose 1*, No. 1: 30–4 (Feb., 1930); *Chem. Abstr. 24:* 1971. Patent review.

328. Rossman, J., History of laminated wall board patents. *Paper Trade J. 86*, No. 3: 45–7 (Jan. 19, 1928). 71 patents listed.

329. Rossman, J., The manufacture of safety paper. I. Special paper structure. II. Chemical surfacing of paper. *Paper Trade J. 87*, No. 10: 61–4; No. 12: 56–60 (Sept. 6, 20, 1928); *Papierfabr. 27*, No. 19: 295–99 (May 12, 1929). 35 and 93 patents listed.

330. Rossman, J., The manufacture of waxed paper. *Paper Trade J. 90*, No. 5: 56–65 (Jan. 30, 1930). 135 patents listed.

331. Rossman, J., Paper sizing patent review. A review of the U. S. patents for sizing by the beater method. *Paper Trade J. 89*, No. 4: 54–60 (July 25, 1929). 88 patents listed.

332. Rowland, B. W., Colloidal aspects of cellulose. *Tech. Assoc. Papers 19:* 428–30 (June, 1936). 34 references.

333. Rudolfs, W., *et al.*, Critical review of the literature on sewage and waste treatment and stream pollution. 1945. *Sewage Works J. 18*, No. 2: 244–83 (March, 1946). 230 references. *1946. Ibid. 19*, No. 2: 207–47 (March, 1947). 234 references. *1947. Ibid. 20*, No. 2: 224–72 (March, 1948). 295 references. *1948. Ibid. 21*, No. 2: 228–67 (March, 1949). 287 references. *1949. Sewage Ind. Wastes 22*, No. 5: 593–655 (May, 1950). 398 references.

334. Rudolfs, W., *et al.* Critical review of the literature of 1951 on sewage, waste treatment, and water polution. *Sewage Ind. Wastes 24*, No. 5: 541–61 (May, 1952). 767 references.

335. Rudolfs, W., *et al.* Review of the literature on sewage and waste treatment and stream pollution, 1934–1936. *Sewage Works J. 9*, No. 6: 998–1018 (Nov., 1937). 105 references. *1938. Ibid. 11*, No. 2: 159–94 (March, 1939). 190 references. *1939. Ibid. 12*, No. 2: 189–243 (March, 1940). 267 references. *1940. Ibid. 13*, No. 2: 187–239 (March, 1941). 250 references. *1941. Ibid. 14*, No. 2: 317–67 (March, 1942). 232 references. *1942. Ibid. 15*, No. 2: 197–241 (March, 1943). 244 references. *1943. Ibid. 16*, No. 2: 222–73 (March, 1944). 275 references. *1944. Ibid. 17*, No. 2: 223–68 (March, 1945). 222 references. *1945. Ibid. 18*, No. 2: 244–83 (March, 1946). 230 references.

336. Rudolfs, W., *et al.* Review of literature on toxic materials affecting sewage treatment processes, streams, and B.O.D. determinations. *Sewage Ind. Wastes 22*, No. 9: 1157–91 (Sept., 1950); *Bull. Inst. Paper Chem. 21:* 117. 177 references.

337. Rudolfs, W., and Heukelekian, H., Biological treatment of industrial wastes. *Chem. Eng. Progr. 48*, No. 9: 449–54; discussion: 454 (Sept., 1952); *Bull. Inst. Paper Chem. 23:* 207. 45 references.

338. Rue, J. D., Cellulose developments, 1918–1938. *Chem. Inds. 44*, No. 1: 28–32 (Jan., 1939); *Bull. Inst. Paper Chem. 9:* 232.

339. Runkel, R., The technical importance of substances accompanying cellulose (hemicelluloses). *Papierfabr. 30*, No. 48: 682; *31*, No. 7: 75–7; No. 8: 86–9; No. 9: 97–100 (Nov. 27, 1932; Feb. 12, 19, 26, 1933); *Chem. Abstr. 27:* 4668; *Brit. Chem. Abstr.* 1933B: 298. 65 references.

340. Rys, L., Annual report on pulp bleaching, 1931. *Zellstoff u. Papier 12*, No. 3: 109–11 (March, 1932). 45 references.

341. Rys, L., and Bönisch, A., Bleaching pulp in 1932. *Zellstoff u. Papier 13*, No. 2: 53–7 (Feb., 1933). 41 references.

342. Rys, L., and Bönisch, A., Advances in pulp bleaching in 1933. *Zellstoff u. Papier* 14, No. 3: 97–100 (March, 1934); *Industria carta (Milan) 1*, No. 6: 253–5 (June, 1934). 33 references.

343. Rys, L., and Bönisch, A., Pulp bleaching. 1935. *Zellstoff u. Papier 16*, No. 4: 133–6 (April, 1936); *Papeterie 68*, No. 13: 599 600; No. 16: 739–40, 743 (July 10, Aug. 25, 1936). 29 references. *1936. Zellstoff u. Papier 16*, No. 12: 577–81 (Dec., 1936). 41 references. *1937. Zellstoff u. Papier 18*, No. 1: 9–12 (Jan., 1938); *Bull. Inst. Paper Chem. 8:* 193; *Chem. Abstr. 32:* 2740. 27 references.

344. Samec, M., and Blinc, M., Recent results in the investigation of starch. *Kolloid-Beih. 47*, No. 9–12: 371–472 (May 19, 1938). 143 references.

345. Samec, M., and Blinc, M., Recent results of starch research. II. The degradation of starch. *Kolloid-Beih. 49*, No. 3–8: 75–314 (Feb. 23, 1939); *Bull. Inst. Paper Chem. 9:* 371. 344 references.

346. Sapp, J. E., The manufacture of semichemical pulps. *Wochbl. Papierfabrik. 23*, No. 80: 872, 874, 876–7 (Dec. 15, 1952); *Bull. Inst. Paper Chem. 23:* 577. 76 references.

347. Schmid, W., Domestic and foreign patent literature on the utilization of the waste liquors and waste gases of the pulp industry (1925–1930). *Papierfabr. 28*, No. 36: 573–5; No. 37: 587–90; No. 39: 620–3; No. 40: 636–9; No. 42: 671–2; No. 45: 717–19; No. 47: 744–6; No. 51/52: 875–7; *29*, No. 1: 10–14 (1930–1931).

348. Schmid, W., Domestic and foreign patents literature on the utilization of the waste liquors and waste gases of the pulp industry and the products obtained therefrom. 1930–1931. *Papierfabr. 29*, No. 42: 665–70 (Oct. 18, 1931).

349. Schrero, N., Water glass, a bibliography. Carnegie Library, Pittsburgh, 1922. 87 p. Paper, p. 66–68.

350. Schroeder, C. A., Foam—bibliography. *Bull. Inst. Paper Chem. 1*, No. 11: 31–4 (July, 1931). 29 references.

351. Schrohe, A., Review of patent literature on chemical methods of preparing pure and refined pulps and fibers. 1898–1925. *Papierfabr. 23*, No. 41: 655–8; No. 42: 665–8; No. 43: 687–9 (Oct. 11, 18, 25, 1925).

352. Schrohe, A., Waste liquors and gases of the paper industry. Survey of the recent domestic and foreign patent literature on the utilization of waste liquors and waste gases of the pulp industry, 1912–1924. *Papierfabr. 23*, No. 3: 30–3; No. 5: 63–5; No. 7: 89–92; No. 10: 158–61; No. 15: 251–3; No. 17: 284–7; No. 18: 293–6; No. 19: 306–7 (1925). Translation with additions by Clarence J. West in *Paper Trade J. 81*, No. 14: 62–4; No. 15: 54–6; No. 17: 56–8; No. 18: 106–8; No. 19: 57–9; No. 20: 54–6; No. 21: 57–8; No. 22: 55–6; No. 23: 61–3; No. 24: 50–2; No. 25: 47–50; No. 26: 50–2 (Oct. 18, 22, 29, Nov. 5, 12, 19, 26, Dec. 3, 10, 17, 24, 1925); *Tech. Assoc. Papers 9:* 146–81 (1926). *German original reprinted with additions of indexes under the title:* Die Verwertung der Zellstoff Ablaugen. Berlin, Elsner, 1925. 140 p. Reviewed in *Paper Trade J. 81*, No. 25: 43; *Pulp Paper Mag. Can. 23:* 1520; *World's Paper Trade Rev. 84:* 1786.

353. Schur, M. O., and Hoos, B. G., Nitration of purified wood fiber. *Ind. Eng. Chem. 29*, No. 1: 26–44 (Jan., 1937); *Cellulose Ind. 13*, No. 5: 154–9 (May, 1937); *Bull. Inst. Paper Chem. 7:* 175; *Chem. Abstr. 31:* 5573. 85 references.

354. Schwartz, H., Utilization of lignin in plastics. Dominion Forest Service, Forest Products Labs., Mimeograph Bull. No. 101. *Pulp Paper Mag. Can. 45*, No. 9: 675–8 (Aug., 1944); *Bull. Inst. Paper Chem. 15:* 55; *Brit. Chem. Physiol. Abstr.* 1944B, II: 362. 70 references.

355. Schweinichen, G. von, Synthetic resins for impregnation of paper. *Materie plastiche 18:* 15–22 (1925); *Packaging Abstr. 10:* 102. 109 references.

356. Science Library, *London.* Recent references to paper-machine felts. Bibl. Series No. 124. 1934. 3 mimeographed pages.

357. Science Museum, *London.* Bibliography on cellophane and glassine. Bibl. Series No. 25, 1934. 2 mimeographed pages.

358. Scribner, B. W., Developments in paper testing. 1935. *Paper Trade J. 102*, No. 5: 43–4 (Jan. 30, 1936); *Tech. Assoc. Papers 19:* 253–4 (June, 1936). 69 references. *1936. Paper Trade J. 104*, No. 11: 53–4 (March 18, 1937); *Tech. Assoc. Papers 20:* 179–80 (June, 1937). 48 references. *1937. Tech. Assoc. Papers 21:* 174–7 (June, 1938). 107 references. *1938. Tech. Assoc. Papers 22:* 395–7 (June, 1939). 54 references. *1939. Tech. Assoc. Papers 23:* 442–5 (June, 1940). 82 references. *1940. Tech. Assoc. Papers 24:* 346–8 (June, 1941); *Paper Trade J. 112*, No. 4: 35–7 (Jan. 23, 1941). 62 references. *1941. Tech. Assoc. Papers 25:* 236 (June, 1942); *Paper Trade J. 114*, No. 8: 137 (Feb. 19, 1942). 31 references. *1942. Tech. Assoc. Papers 26:* 181–2 (June, 1943); *Paper Trade J. 116*, No. 10: 23–4 (March 11, 1943). 29 references. *1943. Tech. Assoc. Papers 27:* 407–8 (June, 1944); *Paper Trade J. 119*, No. 1: 45–6 (July 6, 1944). 40 references. *1944. Tech. Assoc. Papers 28:* 115–16 (June, 1945); *Paper Trade J. 120*, No. 14: 47–8 (April 5, 1945). 39 references.

359. Scribner, B. W., Developments in the physical testing of paper and paperboard. *1944–1945. Tech. Assoc. Papers 29:* 182–3 (June, 1946); *Paper Trade J. 122*, No. 9: 130, 132 (Feb. 28, 1946). 25 references. *1945–1946. Tech. Assoc. Papers 30:* 219–20 (June, 1947); *Paper Trade J. 125*, No. 1: 33–4 (July 3, 1946). 42 references. *1946–1947. Tech. Assoc. Papers 31:* 322–3 (June, 1948); *Paper Trade J. 127*, No. 27: 53–5 (Dec. 30, 1948). 45 references.

360. Sears, G. R., Wink, W. A., and Van den Akker, J. A., Instrumentation studies. LXXIII. A summary of instrumentation reports including the technique of evaluating instruments, *Tappi 35*, No. 8: 156–92A (Aug., 1952); *Bull. Inst. Paper Chem. 23:* 23; *Chem. Abstr. 47:* 863. 80 references.

361. Segall, G. H., and Purves, C. B., Chemical composition of wood barks. *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1946: 98–118; *Pulp Paper Mag. Can. 47*, No. 3: 149–62 (Feb., 1946); *Bull. Inst. Paper Chem. 16:* 379; *Brit. Abstr.* 1946B, II: 243. 64 references.

362. Seiberlich, J., Nitrocellulose from wood pulp. *Pulp*

Paper Mag. Can. 39, No. 1: 17–19 (Jan., 1938); *Bull. Inst. Paper Chem. 8:* 233. 55 references, mostly patents.

363. Seifriz, W., The origin, composition and structure of cellulose in the living plants. *Protoplasma 21:* 129–59 (1934). 113 references.

364. Shorygin, P. P., Latest developments in the domain of cellulose chemistry. *Org. Chem. Ind. (U.S.S.R.) 5:* 162–8 (1938); *Chem. Abstr. 32:* 8131. 40 references.

365. Simmonds, F. A., Résumé of recent literature on hydration theories and associated phenomena. *Tech. Assoc. Papers 18:* 455–9 (June, 1935); *Paper Trade J. 101*, No. 3: 35–9 (July 18, 1935). 35 references.

366. Sineath, H. H., *et al.* Industrial raw materials of plant origin. V. A survey of the bamboos. *Bull. Eng. Exp. Sta. Georgia Inst. Tech. 15*, No. 18 (1953). 230 p. 1034 references.

367. Sisson, W. A., X-ray analysis of textile fibers. IV. A suggested secondary structure for cellulose. *Textile Research 6*, No. 3: 143–51 (Jan., 1936); *Bull. Inst. Paper Chem. 6:* 289. 41 references.

368. Sisson, W. A., X-ray diffraction behavior of derivatives. *Ind. Eng. Chem. 30*, No. 5: 530–7 (May, 1938); *Bull. Inst. Paper Chem. 8:* 410; *Brit. Chem. Physiol. Abstr.* 1938B: 893. 102 references.

369. Sisson, W. A., X-ray studies regarding the structure and behavior of native cellulose membranes. *Chem. Revs. 26*, No. 2: 187–201 (April, 1940); *Bull. Inst. Paper Chem. 10:* 364; *Chem. Abstr. 34:* 4563. 57 references.

370. Siu, R. G. H., and Reese, E. T., Decomposition of cellulose by micro-organisms. *Botan. Rev. 19*, No. 7: 377–416 (July, 1953); *Bull. Inst. Paper Chem. 23:* 875. 189 references.

371. Skjenneberg, A. C., The technical development of the wood-pulp industry during the last 25 years. *Papir-J. 27*, No. 16: 217–18, 220–1 (Aug. 31–Sept. 6, 1939); *Bull. Inst. Paper Chem. 10:* 92.

372. Smirnov, V. A., Advances in the uses of hemicelluloses. *Uspekhi Khim. 17:* 468–85 (1948). 128 references.

373. Smith, E. V., and Shaw, T. P. G., Bibliography on resin analysis. *Tappi 34*, No. 5: 123–8A (May, 1951); *Bull. Inst. Paper Chem. 21:* 726. 251 references.

374. Snyder, E. G., The burning of pyrites. Appleton, Wis., The Institute of Paper Chemistry, 1952. 346 references.

375. Society of Chemical Industry. Fibres, textiles, cellulose and paper. *Ann. Repts. Progr. Appl. Chem. 1+, 1916+.* Reprinted in part in: *Paper Makers' Monthly J. 58*, No. 6: 193, 195, 197; No. 7: 229, 231; No. 8; 253–5, 257; No. 9: 290–2; No. 12: 417–19 (1920); *59*, No. 1: 9–13; No. 5: 178–80; No. 6: 245–8, 249, 259; No. 7: 281–3; No. 8: 311–14; No. 12: 489, 491, 493 (1921); *60*, No. 1: 16–18; No. 2: 47–9; No. 3: 93, 95; No. 4: 128–9, 131, 151; No. 7: 295–9; No. 10: 387, 389, 391; No. 11: 421, 423; No. 12: 467–9 (1922); *61*, No. 1: 29, 31, 33, 37; No. 2: 67–8, 73, 75, 77; No. 3: 117, 119, 121; No. 4: 164–5, 167; No. 10: 421, 423, 425; No. 11: 461, 463, 465; No. 12: 499, 501, 503 (1923); *62*, No. 2: 67–8, 71, 73, 75; No. 3: 115, 117, 119, 121; No. 4: 145–7; No. 5: 199–200; No. 6: 250–3; No. 9: 372–4; No. 11: 460–3; No. 12: 501–3 (1924); *63*, No. 1: 13, 15, 17; No. 3: 100–3, 105; No. 5: 177–9 (1925); *Paper 30*, No. 11: 7–11; No. 13: 7–10; No. 15: 14–15; No. 16: 11; No. 20: 16–17; No. 21: 10; No. 22: 17 (May 17, 31, June 14, 21, July 19, 26, Aug. 2, 1922).

376. Southgate, B. A., Sanitation and water purification. *Repts. Progr. Appl. Chem. 33:* 652–69 (1948); *Bull. Inst. Paper Chem. 20:* 351. 116 references.

377. Speakman, J. B., and Stott, E., Textiles, fibres, and cellulose. *Repts. Progr. Appl. Chem. 20:* 158–89 (1935). 244 references. *21:* 153–81 (1936). 212 references.

378. Speakman, J. B., Whewell, C. S., and Turner, H. A., Fibres, textiles, and cellulose. *Repts. Progr. Appl. Chem. 22:* 166–251 (1937). 328 references.

379. Stafford, R. W., and Shay, J. F., Coatings. *Anal. Chem. 25*, No. 1: 8–11 (Jan., 1953); *Bull. Inst. Paper Chem. 23:* 437. 138 references.

380. Stamm, A. J., Colloid chemistry of cellulosic materials. U. S. Dept. Agr., Forest Service 240MP. 1936. 91 p. 280 references. *Chem. Abstr. 30:* 8601.

381. Standing, H. A., The dyeing of cellulose with direct dyes. I. A review of the literature. *Trans. Faraday Soc. 41*, No. 7: 410–34 (July, 1945); *Bull. Inst. Paper Chem. 16:* 95; *Chem. Abstr. 39:* 5493. 119 references.

382. Staudinger, H., Cellulose. FIAT review of German science 1939–1946, Preparative organic chemistry, Part III: 1–48 (1948); *Bull. Inst. Paper Chem. 20:* 307. 285 references.

383. Staudinger, H., Highly polymerized compounds. 153. The constitution of cellulose. *Svensk Kem. Tid. 49*, No. 1: 3–23 (Jan., 1937); *Bull. Inst. Paper Chem. 7:* 214; *Chem. Abstr. 31:* 4107. 63 references.

384. Staudinger, H., Highly polymerized compounds. 192. (Cellulose. 38). The relation between the constitution of cellulose and its physical properties. I-III. *Papier-Fabr. 36*, No. 35: 373–9; No. 36: 381–8; No. 47: 473–80; No. 48: 481–5 (Aug. 26, Sept. 2, Nov. 18, 25, 1938); *Bull. Inst. Paper Chem. 9:* 189; *Chem. Abstr. 32:* 8765; *33:* 2339; *Brit. Chem. Physiol. Abstr.* 1939B: 132. 67 references.

385. Staudinger, H., Macromolecular compounds. 288. The micellar, macromolecular, and supermolecular structure of cellulose. *Cellulosechemie 20*, No. 1: 1–14 (Jan./Feb., 1942); *Bull. Inst. Paper Chem. 13:* 135. 132 references.

386. Stawitz, J., Colloid-chemical properties of water-soluble methylcelluloses. *Melliand Textilber. 33*, No. 7: 620–3; No. 8: 737–8 (July, Aug., 1952); *Bull. Inst. Paper Chem. 23:* 710. 50 references.

387. Steele, R., and Messler, C., Review of textile research and development during 1951. *Textile Research J. 22*, No. 5: 293–377 (May, 1952). 1758 references. Classified. Chemistry of cellulose and starch, p. 334–9; structure and properties of cellulose fibers, p. 339–42.

388. Steele, R. O., *et al.* Review of textile research and development during 1950. *Textile Research J. 21*, No. 5: 293–373 (May, 1951). 1622 references. Classified. Chemistry of cellulose and starch, p. 336–9; structure and properties of cellulose fibers, p. 339–41.

389. Steinmann, R., Cellulose chemical research. 1937 and 1938. *Zellstoff u. Papier 19*, No. 3: 123–8; No. 4: 210–13; No. 6: 329–30, 332, 334 (March, April, June, 1939); *Bull. Inst. Paper Chem. 9:* 524. 111 references. *1939. Zellstoff u. Papier 20*, No. 4: 119–20, 122, 124, 126, 128–9; No. 5: 147–9 (April, May, 1940); *Bull. Inst. Paper Chem. 11:* 138. 47 references.

390. Stone, J. E., and Wells, S. D., Alkaline pulping progress. *Tappi 36*, No. 11: 38A, 40A, 42A, 44A, 46A, 48A, 50A, 52A, 56A, 58A, 60A, 62A (Nov., 1953); *Southern Pulp Paper Mfr. 16*, No. 10: 55–8, 60, 62, 64, 66, 68, 70 (Oct. 1, 1953); *Bull. Inst. Paper Chem. 24:* 176. 215 references.

391. Stream pollution bibliography. *Paper Trade J. 82*, No. 12: 47–8 (March 25, 1926).

392. Surface, H. E., Bibliography of the pulp and paper industries. Washington, Govt. Print. Off., 1913. 48 p. (U. S. Dept. of Agriculture. Forest Service. Bulletin 123. Forest Products Laboratory Series).

393. Sutermeister, E., A review of the literature of sizing. *Tech. Assoc. Papers 19:* 460–79 (June, 1936); *Paper Trade J. 97*, No. 4: 18, 21–5; No. 21: 26–8, 31; No. 22: 20–5 (July 27, Nov. 23, 30, 1933); *98*, No. 1: 25–31 (Jan. 4, 1934); TAPPI, Special Report No. 261. Sept. 11, 1936. References through the text.

394. Sutermeister, E., A review of the literature on sizing. *Paper Ind. 29*, No. 10: 1455–8; No. 11: 1600–3; No. 12: 1761–5 (Jan., Feb., March, 1948); *Bull. Inst. Paper Chem. 18:* 538; *Brit. Abstr.* 1948B, II: 309.

395. Tall Oil Association. Tall oil in asphalt products. *Tall Oil in Ind. Bull.* No. 12: 4 p. (June, 1953); *Tappi 36*, No. 8: 108–11A (Aug., 1953); *Bull. Inst. Paper Chem. 23:* 921. 52 references.

396. TAPPI. *Committee on Abstracts and Bibliography.* Papermaking Abstracts. Vol. I. New York, N. Y., TAPPI, 1941, 1942. 270 p.

397. TAPPI. Kraft mill odor literature. Special Report No. 296. Sept. 28, 1939. 12 p. Processed. Annotated list of periodical articles and patents.

398. Textor, C. K., Sulphate pulp and kraft paper. List of references covering the literature up to 1912. *Paper Trade J. 73*, No. 4: 46–54; No. 6: 46–54; No. 7: 54–60 (July 28, Aug. 11, 18, 1921).

399. Thompson, J. O., Swanson, J. W., and Wise, L. E., Hemicelluloses and arabogalactans as beater adhesives. *Tappi 36*, No. 12: 534–41 (Dec., 1953); *Bull. Inst. Paper Chem. 24:* 357. 28 references.

400. Timell, T. E., Studies on carboxymethylcelluloses. V. The relative reactivity of the hydroxyl groups of cellulose. *Svensk Papperstidn. 56*, No. 13: 483–90 (July 15, 1953); *Bull. Inst. Paper Chem. 24:* 11. 51 references.

401. Toovey, T. W., Cuprammonium viscosity as a control method: review. *Tech. Assoc. Papers 25:* 312–16 (June, 1942); *Bull. Inst. Paper Chem. 13:* 138. 82 references.

402. Toth, G., Hydrolytic degradation products of cellulose. *Z. Papier, Pappe, Zellulose Holzstoff 56*, No. 23/24: 309–13 (Dec. 19, 1938); *Bull. Inst. Paper Chem. 9:* 232. 42 references.

403. Transparent wrapping materials. A review of manufacture and properties of cellulose films that compete with paper. *Pulp Paper Mag. Can. 37*, No. 7: 375–8 (June, 1936). 56 references.

404. Treiber, E., Absorption spectra of cellulose and its derivatives with particular reference to technical applications, especially in the viscose industry. *Kolloid-Z. 130*, No. 1: 39–63 (Jan., 1953); *Bull. Inst. Paper Chem. 23:* 537. 76 references.

405. Trenschel, R., Technical advances in pulp and paper industry. 1932–1934. *Zellstoff u. Papier 13*, No. 3: 106–16 (March, 1933); *Boll. staz. sper. ind. carta 12*, No. 6: 74–8 (June, 1933). 89 references. *Zellstoff u. Papier 14*, No. 4: 148–52;

No. 5: 200–6 (April, May, 1934); *15*, No. 5: 198–201; No. 6: 238–40; No. 7: 279–82 (May-Aug., 1935). 50 references.

406. Turner, A. J., Long vegetable fibres. *Rev. Textile Progr. 1:* 131–42 (1949). 79 references.

407. Turner, H. A., Cellulose textile chemistry. *Repts. Progr. Appl. Chem. 34:* 524–61 (1949). 312 references.

408. Turner, H. A., Cotton and cellulose. *Repts. Progr. Appl. Chem. 22:* 195–251 (1937). 328 references.

409. Tyden, H., The determination of alpha-cellulose. *Ing. Vetenskaps Akad., Handl.* No. 175. 1953. 83 p. 206 references. *Bull. Inst. Paper Chem. 15:* 449; *Chem. Abstr. 39:* 3928; *Tech. Bull. Tech. Sect., Brit. Paper and Board Maker's Assoc. 22:* 38.

410. Underhay, G. F., Pulp and paper. *Repts. Progr. Appl. Chem. 19:* 177–208 (1934). 214 references.

411. Unruh, C. C., and Kenyon, W. O., The formation and properties of oxidized celluloses. *Textile Research J. 16*, No. 1: 1–12 (Jan., 1946); *Bull. Inst. Paper Chem. 16:* 276; *Chem. Abstr. 40:* 2623; *Tech. Bull. Tech. Sect., Brit. Paper and Board Makers' Assoc. 23:* 18. 117 references.

412. Van Horn, W. M., Progress in stream improvement. Part 1. The spent sulfite liquor problem. *Paper Ind. 34*, No. 12: 1456–8 (March, 1953); *Bull. Inst. Paper Chem. 23:* 672. 48 references.

413. Vestergren, J., Recent industrial and scientific advances in the paper industry. *Svensk Papperstidn. 41*, No. 15: 458–67; No. 16: 485–90; No. 17: 511–18; No. 18: 539–45; No. 24: 703–17 (1938); *Chem. Abstr. 33:* 3141. 134 references.

414. Wacek, A. von, The present knowledge of the chemistry of lignin. *Holz Roh- u. Werkstoff 1*, No. 14: 543–48 (Nov., 1938); *Bull. Inst. Paper Chem. 9:* 201; *Chem. Abstr. 33:* 3144. 71 references.

415. Wells, S. D., Progress in alkaline pulping in 1946. *Tech. Assoc. Papers 30:* 591–6 (June, 1947); *Paper Trade J. 125*, No. 18: 42–7 (Oct. 30, 1947); *Bull. Inst. Paper Chem. 18:* 145. 114 references.

416. Wells, S. D., Progress in alkaline pulping in 1947. *Southern Pulp Paper Mfr. 11*, No. 10A: 56, 58, 60, 62, 64, 66 (Oct. 31, 1948); *Tappi 32*, No. 6: 35–41A (June, 1949); *Bull. Inst. Paper Chem. 19:* 225. 182 references.

417. Wells, S. D., Progress in alkaline pulping in 1948. *Southern Pulp Paper Mfr. 12*, No. 10A: 44, 47–8, 50, 52, 54, 56 (Oct. 31, 1949); *Tappi 32*, No. 12: 36A, 38A, 40A, 42A, 44A, 46A, 48A, 50A (Dec., 1949); *Bull. Inst. Paper Chem. 20:* 232. 335 references.

418. Wells, S. D., Progress in alkaline pulping in 1949. *Tappi 33*, No. 10: 68A, 70–84A (Oct., 1950); *Southern Pulp Paper Mfr. 13*, No. 10: 32, 34, 36, 42, 44, 46, 48 (Oct., 1950); *Bull. Inst. Paper Chem. 21:* 149. 393 references.

419. Wells, S. D., Alkaline pulping progress in 1950. *Southern Pulp Paper Mfr. 14*, No. 10: 40–2, 44, 46, 48, 50, 52, 57–8, 60, 186–7 (Oct. 1, 1951); *Tappi 34*, No. 11: 24A, 26A, 28A, 30A, 32A, 34A, 38A, 40A, 42A, 46A, 48A, 50A, 52A, 54A (Nov., 1951). 634 references.

420. Wells, S. D., Alkaline pulping process in 1951. *Southern Pulp Paper Mfr. 15*, No. 10: 42, 46, 48, 50, 52, 64, 59, 62–4, 66 (Oct. 1, 1952); *Tappi 35*, No. 10: 42A, 44A, 46A, 48A, 50A, 52A, 54A, 56A, 58A, 60A, 62A, 64A, 66A (Oct., 1952); *Bull. Inst. Paper Chem. 23:* 159. 670 references.

421. Werth, — van der, General methods of utilizing pulp waste liquors, based on a survey of German patents. *Zellstoff u. Papier 16*, No. 10: 456–9 (Oct., 1936); *Bull. Inst. Paper Chem. 7:* 92; *Chem. Abstr. 31:* 1202.

422. Whistler, R. L., Preparation and properties of starch esters. *Advances in Carbohydrate Chem. 1:* 279–307 (1945). 150 references.

423. Whistler, R. L., Xylan. *Advances in Carbohydrate Chem. 5:* 269–90(1950). 140 references.

424. Whiting, A. G., Summary of the literature on milkweeds (*Ascelepias spp.*) and their utilization. U. S. Dept. Agr., Bibliographical Bull. No. 2. Oct. 15, 1943. 41 p. Bibl., p. 35–41. Utilization for paper. p. 29–30.

425. Wilcox, J. K., Cellophane. A bibliography. John Crerar Library, Reference List No. 11. 1931. 12 p. Mimeographed.

426. Wildman, H. B., Textile microscopy, with special reference to the microscopy of natural fibers. *Rev. Textile Progr. 1:* 319–23 (1949). 26 references.

427. Willets, W. R., Hydrogen ion methods in the paper industry. *Paper Trade J. 93*, No. 1: 37–41 (July 2, 1931). 94 references.

428. Wilson, H. A. B., Methods of reducing the consumption of chlorine pulp in bleaching; a literature survey. *Paper-Maker (London) 124*, No. 5: 403–4, 410–11 (Nov., 1952); *Bull. Inst. Paper Chem. 23:* 391. 90 references.

429. Winding, C. C., and Wiegandt, H. F., Polymerization. *Ind. Eng. Chem. 45*, No. 9: 2011–22 (Sept., 1953); *Bull. Inst. Paper Chem. 24:* 130. 557 references.

430. Wise, L. E., Cellulose, lignin and papermaking studies. Results of recent research in this field of chemistry by German investigators. *Paper Ind. 15*, No. 9: 509–11; No. 10: 568–71 (Dec., 1933; Jan., 1934); Bibl., p. 511, 570. 90 references.

431. Wise, L. E., Cellulose research, 1933–37. A résumé. I. Molecular weight of cellulose. II. Miscellaneous investigations. *Paper Ind. 20*, No. 4: 413–16; No. 5: 540–3 (July, Aug., 1938); *Bull. Inst. Paper Chem. 8:* 462; *9:* 10. 29 and 46 references.

432. Wise, L. E., Cellulose research, 1933–1937. III. Cellulose modified by hydrolysis and oxidation. *Paper Ind. 20*, No. 9: 956–8 (Dec., 1938); *Bull. Inst. Paper Chem. 9:* 191. 21 references.

433. Wise, L. E., The chemistry of the hemicelluloses. *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1949: 159–66; *Pulp Paper Mag. Can. 50*, No. 3: 179–86 (Feb., 1949); *Bull. Inst. Paper Chem. 19:* 537; *Chem. Abstr. 43:* 3609. *Brit. Abstr.* 1949B, II: 773. 54 references.

434. Wise, L. E., The hemicelluloses. *Tappi 36*, No. 12: 155–6A (Dec., 1953); *Bull. Inst. Paper Chem. 24:* 357. 30 references.

435. Wise, L. E., Hemicelluloses in the pulp industry. *Paper Ind. 21*, No. 6: 653–6 (Sept., 1939); *Bull. Inst. Paper Chem. 10:* 46; *Brit. Chem. Physiol. Abstr.* 1941B, II: 378. 26 references.

436. Wise, L. E., and Buchanan, M. A., The chemistry of the cellulosic wood fiber. *Paper Ind. 34*, No. 10: 1229–32 (Jan., 1953); *Bull. Inst. Paper Chem. 23:* 396. 25 references.

437. Wise, L. E., and Peterson, F. C., Cellulose and paper. *Ann. Survey Am. Chem. 3:* 313–23 (1928). 83 references. 4: 443–58 (1928–1929).

438. Withers, J. C., Fibres, textiles, cellulose and paper. *Repts. Progr. Appl. Chem. 13:* 136–56 (1928). 92 references. *14:* 145–69 (1929). 135 references. *15:* 133–54 (1930). 126 references.

439. Withers, J. C., Textiles, fibres, and cellulose. *Repts. Progr. Appl. Chem. 18:* 142–64 (1933). 112 references.

440. Wolfram, M. L., and Morgan, P. W., Survey of the literature on cellulose and allied substances—1938–1940. I. General chemical properties of cellulose. *Tech. Assoc. Papers 25:* 706–11 (June, 1942). 106 references.

441. Yarsley, V. E., Fibres, textiles, cellulose and paper. *Repts. Progr. Appl. Chem. 16:* 154–78 (1931). 114 references.

442. Yarsley, V. E., Textiles, fibres, and cellulose. *Repts. Progr. Appl. Chem. 17:* 144–65 (1932). 51 references.

443. Yorston, F. H., Advances in the chemistry of wood. 1938–1939. *Pulp Paper Mag. Can. 41*, No. 2: 144–8 (Feb., 1940); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1940: 9–13; *Bull. Inst. Paper Chem. 10:* 266. 54 references. *1941. Pulp Paper Mag. Can. 43*, No. 2: 203–5 (Feb., 1942); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1942: 37–9. 36 references. *1942. Pulp Paper Mag. Can. 44*, No. 2: 197–8, 200 (Feb., 1943); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1943: 36–7; *Bull. Inst. Paper Chem. 13:* 341. 38 references. *1943. Pulp Paper Mag. Can. 45*, No. 3: 266, 268, 270 (Feb., 1944); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1944: 49–52; *Bull. Inst. Paper Chem. 14:* 263. 36 references. *1944. Pulp Paper Mag. Can. 46*, No. 3: 276, 278, 280 (Feb., 1945); *Proc. Tech. Sect., Can. Pulp Paper Assoc.* 1945: 29–31; *Bull. Inst. Paper Chem. 15:* 308. 33 references.

444. Zettlemoyer, A. C., Fetsko, J. M., and Walker, W. C., Printing ink—paper relationships. II. Numerical evaluation of letterpress print and printing quality. *Tappi 36*, No. 2: 161–9A (Feb., 1953); *Bull. Inst. Paper Chem. 23:* 500. 71 references.

445. Zwicker, B. M. G., Latices of flexible synthetic polymers. *Ind. Eng. Chem. 44*, No. 4: 774–86 (April, 1952); *Bull. Inst. Paper Chem. 22:* 667. 194 references.

LITERATURE CITED

1. *The Bibliographic Index.* New York, H. H. Wilson Co., 1938 to date.
2. Gaudenzi, N., Guida Bibliografica Internazionale per il Chimico. Libre e Riviste. Firenze, Italy. Carlo Manfredi Editore Milano, 1952. 509 p.
3. Crane, E. J., and Patterson, A. M., Guide to the literature of chemistry. New York, John Wiley and Sons, 1927. 438 p.
4. *Bulletin [Library Notes] of The Institute of Paper Chemistry.*
5. West, C. J., Bibliography of pulp and paper making, 1900–1928. New York, Lockwood Trade Journal Co., 1929. 982 p. Classified.
6. West, C. J., Bibliography of pulp and paper making, 1928–1935. New York, Lockwood Trade Journal Co., 1936. 803 p. Classified.
7. West, C. J., Bibliography of pulp and paper manufacture, 1936–1945. New York, Technical Association of the Pulp and Paper Industry, 1947. 1053 p. Classified.
8. West, C. J., Pulp and paper manufacture. Bibliography, 1946–1950. New York, Technical Association of the Pulp and Paper Industry, 1951. 752 p. Classified.

The Literature Spectrum of Cellulose Chemistry

HERMAN SKOLNIK and LANE F. McBURNEY

THE preceding papers in this symposium have told us *where* to find the literature of cellulose, and the following paper will tell us *how* to find the literature. The purpose of this paper is to describe the *who*, *what*, *why*, and *when* of the literature.

Strictly speaking, when time is considered as a term in the analysis of a literature, we tend to call the results a history. However, what this paper deals with is not a historical account, but rather an aggregation of time with the forces behind the scientists and discoveries important to the development of cellulose chemistry and technology. In relating the parameters *who*, *what*, *why*, and *when*, the picture we would like to present has the characteristics of a spectrum bringing into focus the component factors arranged in the order of their histroical perspectives. Because the spectrum of cellulose chemistry has such a wide range, we have broken it down into the five broad bands—papermaking and paper pulp, cellulose nitrate, cellulose derivatives, rayon, and scientific developments.

PAPERMAKING AND PAPER PULP

The art of papermaking and the search for new sources of cellulose for paper pulp make a significant story for relating economic and social environment to incentives and technological developments. Papermaking is closely allied with those civilizations in which literacy and communication have been regarded highly. Although the first mechanical pulp is credited to the Egyptians who made paperlike material from papyrus reeds as early as 2000 B.C., true paper, as we know it today, was first made in China about 100 B.C. from the bark of the mulberry tree. Papermaking was introduced to the western civilization from China through the invading Moslem armies during the 8th century. By the 15th century, paper, based on linen and cotton rags, had replaced vellum and parchment in Europe. The principles of papermaking today are essentially the same as imparted to us from China. This brief history brings us up to the beginning of the spectrum shown in Fig. 1.

The papermaking machine introduced around 1800 and the expanding interest in newspaper reading created a great shortage of rags. The response to this challenge came from the United States, England, Germany, Sweden, and France where considerable work was undertaken to prepare cellulose from straw, grass, and wood. Straw pulp had an abortive success in the United States, but the uncertainty of its production accompanied by market speculation boded ill for its future. Tilghman's successful introduction and development of the sulphite process, followed closely by Dahl's sulphate process, relegated rags to a minor position as a raw material for papermaking. Recent research and progress in paper pulp and purified wood cellulose are concurrently centered in the United States, the greatest user of pulp and chemical cellulose, and in Sweden, Norway, Canada, and Australia, each of whose economy leans heavily on forest land.

In view of the relationship between papermaking and the advancement of civilization, let us pause for a moment to compare the United States' per capita consumption of paper of about 400 lb. per year to that of Russia's 10 and China's 3 lb. An economy based on our consumption obviously has a high and continuing stake in research and development of cellulose chemistry. Indeed, this explains a Dr. West in our economy.

HERMAN SKOLNIK and LANE F. MCBURNEY, Hercules Experiment Station, Hercules Powder Co., Wilmington, Del.

CELLULOSE NITRATE

Cellulose nitrate, born in 1833, became the progenitor of the industries of explosives, plastics, protective coatings, photographic films, and synthetic fibers, as shown in Fig. 2.

The early history of cellulose nitrate is associated largely with the militaries of most European nations. In fact, during the second half of the 19th century, cellulose nitrate was the cause of an armament race among the European nations. The use of cellulose nitrate in propellants is based upon pioneering work of Schönbein and of Abel. Double-base smokeless powder, a mixture of cellulose nitrate and nitroglycerin known by several names, was discovered and introduced almost simultaneously by Abel in England, Nobel in Sweden, and Schultze in Germany.

In World War I, cellulose nitrate was made from cotton linters in the United States. The unavailability of cotton linters in Germany during World War I and a cotton crop shortage in the United States in 1918 instigated research on the use of cellulose from wood pulp which was plentiful. The incentive in Germany was great, and researches there were partially successful in developing a nitration grade of chemical cellulose from wood. Completely satisfactory and economically feasible processes were not developed, however, until the 1930–40 period.

Paralleling the development of the cellulose nitrate explosives industry was the cellulose nitrate plastics industry. The early literature leading to the introduction of the first plastic was written by Ménard, a poet and artist; Maynard, a medical student; the Reverend Hannibal Goodwin, who was interested in showing stereopticon slides to his parishioners; Parkes, a brother of a chemist; and Hyatt, a journeyman printer. Now, what shall we say is the literature of this group of nonchemists and their associates? The movement during this period was from the applied science or art to the pure science. The literature is almost completely that of the patent art and resulted from research consisting of trying everything in the drugstore. The key to the development of the first plastic was the trial-and-error discovery of camphor as the plasticizer. The Celluloid Co. was formed in 1872 to exploit the results of this discovery. It is interesting to note the best plasticizer for cellulose nitrate, despite the thousands suggested, is still camphor.

Wilson and Green in 1884 obtained their patent on pyroxylin solutions, which became the precursor of the present-day coated textiles, rubber, and paper. Artificial leather, a well-known commodity during our parents' youth, remained within the luxury class goods until after World War I. The important research during this period was on control of the viscosity of cellulose nitrate solutions; progress was gradual and almost haphazard among the many investigations centered in the United States and England.

At the end of World War I, a combination of economic and technological situations led to the application of cellulose nitrate in lacquers and films. The war economy left the United States with an overabundant supply of chemical cellulose, a large supply of cellulose nitrate no longer needed in munitions, and a great supply of butyl alcohol and acetone. The rapidly expanding automobile industry needed a quick-protective coating. The need was satisfied by 1923, and an automobile with a cellulose nitrate lacquer finish first appeared. Within 4 years, every automobile manufactured was finished with a cellulose nitrate lacquer. Because protective coatings for automobiles was a tremendous market, alkyds entered it to compete with cellulose nitrate. This competition was met by the development of spray lacquers based on lower viscosity cellulose nitrate. The economy of the lacquer industry required a large supply of cheap volatile solvents. These were made possible by the Weizmann fermentation process and by the entry into chemicals of petroleum companies with hydrocarbon and chlorinated hydrocarbon solvents.

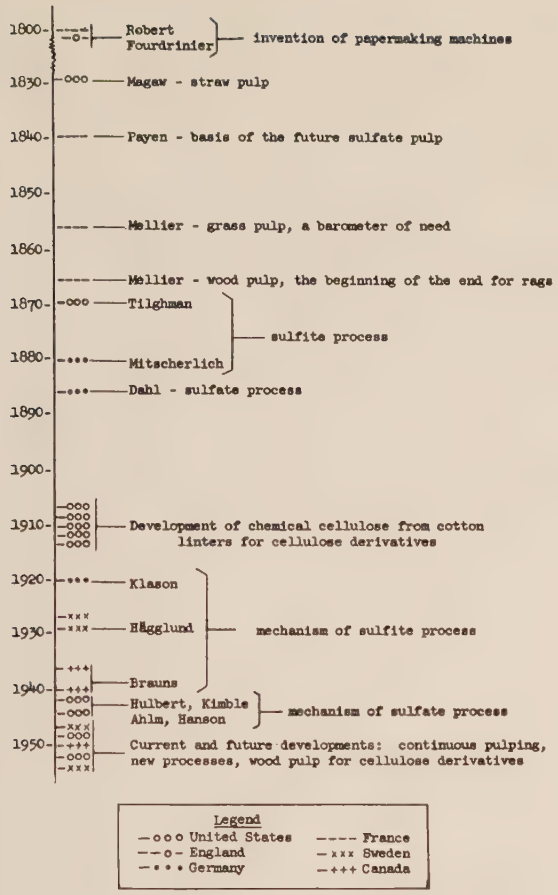

Fig. 1. Spectrum of papermaking and sources of cellulose

The major outlets for cellulose nitrate today are in explosives, automobile and furniture lacquers, coated fabrics, and plastics. Industrially, it has encountered more competition than any other chemical and, in each case, it was cellulose nitrate that was first used in the applications. It has survived its competitive battles, wounded, yes—but not vanquished. Like "Ol' Man River," it just keeps rolling along. Possibly the most ironic competitive battles it had to engage in were those against its own kin—other cellulose derivatives, whose spectrum, along with rayon's is shown in Fig. 3.

CELLULOSE DERIVATIVES

Aside from the cellulose derivatives employed in rayon manufacture, the nitrate remained the only cellulose derivative of commerce until World War I. The first acetone-soluble acetate was reported by Miles in 1905, although the first acetylation of cellulose was described by Schützenberger, 40 years earlier.

Cellulose acetate, during World War I, attracted attention as an airplane dope and for this use eventually replaced cellulose nitrate. During the 1920's, industrial research resulted in the advent of acetate fiber, produced by the Celanese Corp., and acetate photographic film, made by Celluloid and Eastman Kodak. In 1927, the Celluloid Co., in affiliation with Celanese, manufactured cellulose acetate plastic in sheets, rods, and tubes. A new industry was entering our economy by 1928—the custom molding of plastics, with cellulose acetate leading the way. The birth of this new industry stimulated inventions for molding machines, both compression and injection.

A basis was formulated during the period 1905–16 for the etherification of cellulose, and resulted in the preparation of benzylcellulose, ethylcellulose, and methylcellulose. In the United States, the first producer of ethylcellulose was Hercules Powder Co., with production beginning in 1935. Methylcellulose became a chemical of commerce when Dow began manufacturing it in 1939.

Cellulose butyrate and cellulose propionate, both described in the patent literature in 1922 and 1931, respectively, have not become commercial products. The mixed ester, cellulose acetate butyrate was patented in 1932, and later manufactured for use in the making of injection moldings.

Carboxymethylcellulose, first described in 1921, was in small commercial production in Germany by 1924. By the mid-thirties, its production was expanded in Germany to substitute for and eventually to replace natural gums from Asia and the Near East. Commerical production of carboxymethylcellulose in our country was started by Hercules Powder Co. in the 1940's.

The treatment of cellulose fibers with alkaline solutions is one of the oldest and most important reactions of cellulose. After over 100 years of research, the full significance of Mercer's experiments and Schweizer's observations is not fully understood. Mercerization developed into an important industrial process following the work of Lowe in England on the properties cotton acquired by treatment with caustic soda while under tension.

Since Mercer's discovery, the knowledge of fiber structure has been immeasurably enriched by hundreds of scientific investigations, even though the industrial practices in mercerization have been influenced only slightly. The chemical understanding of the mercerization process has arisen mostly since 1920 from studies on the mechanism of the reaction between cellulose and alkaline solutions.

RAYON

Victorian England, through its textile industry, was clothier to most of the world. A John Mercer and mercerization were a natural in this industrial and economic environment. At the same time, France was the purveyor of luxuries, and its silk industry was practically a national institution. The projection of this fact onto the unfortunate event when the silkworms of southern France became stricken with a disease explains the compelling force behind Count de Chardonnet's search for a synthetic silk.

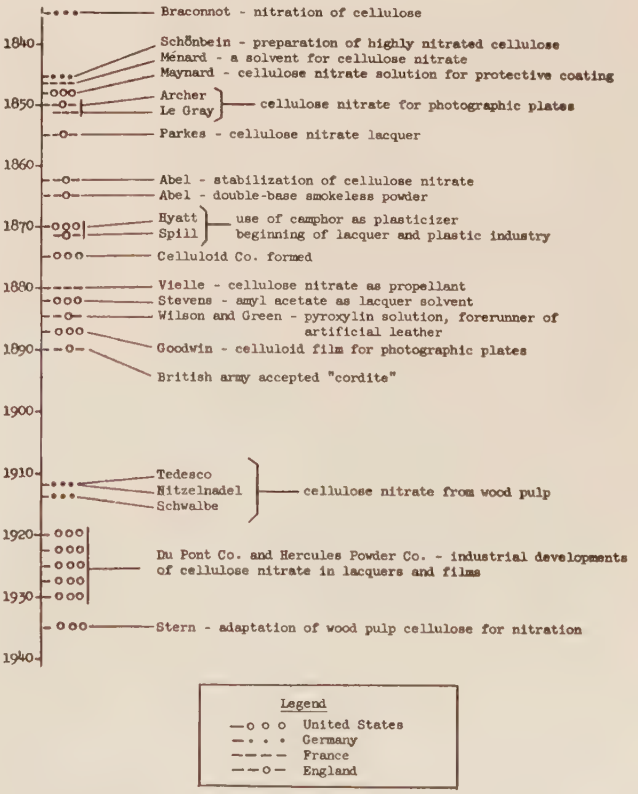

Fig. 2. Spectrum of cellulose nitrate

The background leading to Chardonnet's success began with Swan's work on filaments for incandescent lights. Swan's continuous filament, prepared by forcing collodion through a tiny hole, suggested to him a textile fiber, which he exhibited as artificial silk at the 1885 Exhibition of Inventions in London. Chardonnet had constructed a cellulose nitrate spinning plant the year before. After a fire accident in which a gown burned at the touch of a cigar, Chardonnet secured rights to Swan's denitrating process, and by 1891 factories in France, Switzerland, Belgium, and Hungary were successfully producing a cellulose textile fiber by the denitration of spun cellulose nitrate.

Powell's contemporary work on incandescent light filaments led him in 1884 to the discovery of regenerated cellulose filaments. The first patent for making regenerated cellulose yarn from a cuprammonium solution was granted in 1890 by France to Despeissis. Cuprammonium yarn, however, did not become a commercial commodity until the Bemberg Co. started production in plants in the United States, England, Italy, and Japan.

Similarly, the viscose process was discovered and developed for the manufacture of incandescent filaments. The xanthate process was patented in 1892 by Cross, Bevan, and Beadle, and in 1894 the Viscose Syndicate, Ltd. was formed. Credit for recognizing the possible utilization of this new viscose as a textile fiber belongs to Stearn, an amateur physicist and professionally a cashier in the Liverpool branch of the Bank of England. Stearn, with Cross, formed the Viscose Spinning Syndicate to develop the textile right of the Cross and Bevan patents. Topham, a glassblower employed by Stearn, worked out the process, including the discovery of the necessary ripening of viscose solutions, and the development of multiple-filament spinning by twisting. Aggressive research by the viscose producers and more favorable costs of viscose rayon manufacture displaced cellulose nitrate in textiles.

Cellulose acetate, the late-comer in the rayon industry, had a long gestation period between 1900 and 1930. The cost of cellulose acetate compared to the viscose and cuprammonium

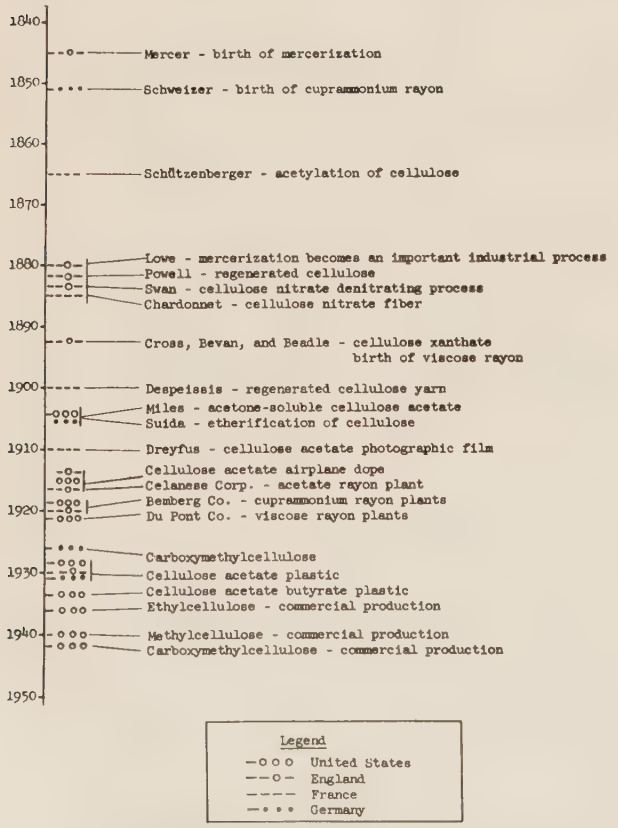

Fig. 3. Spectrum of rayon and other cellulose derivatives

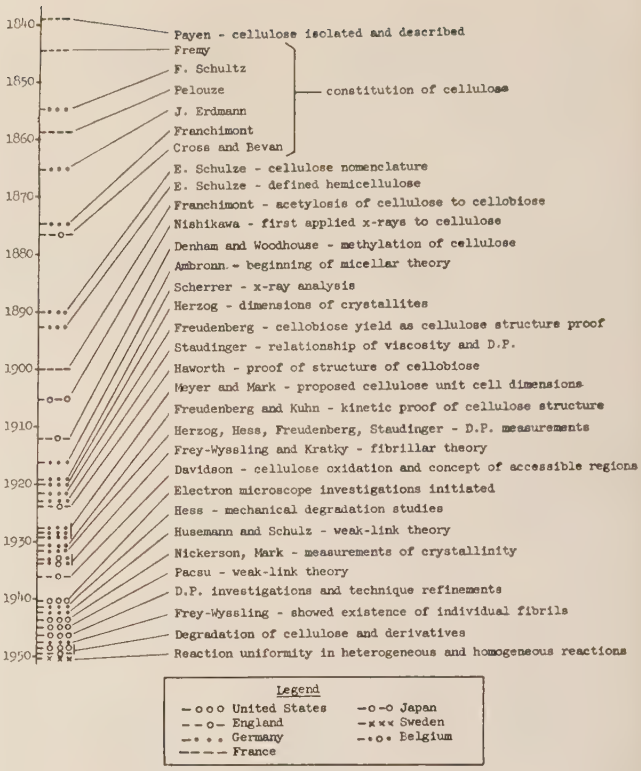

Fig. 4. Spectrum of scientific developments in cellulose chemistry

processes was probably the greatest deterrent in its development as a textile fiber. It was not obvious, furthermore, to the early workers that completely acetylated cellulose was misdirecting their energies. Indeed, it was not until Miles in 1914 attempted to acetylate cellulose by swelling the cellulose with sulphuric acid and obtained a 55% cellulose acetate instead of the usual 62% that it could be spun properly from a solution.

Two young Swiss brothers, Camille and Henry Dreyfus, were the ones who looked upon cellulose acetate seriously. Their interest, however, at first was motivated by a desire to produce cellulose acetate photographic film to replace the flammable cellulose nitrate. World War I, through its insatiable appetite for cellulose acetate airplane dope, put the Dreyfus brothers in a position to begin intensive work on an acetate yarn process at the end of the war. By 1919, they established Celanese Ltd. in England for the manufacture of acetate fibers and fabrics, and in 1924 the American branch was opened.

The basic techniques of modern viscose, acetate, and cuprammonium industries have changed only slightly. The three processes use about the same mechanical and chemical procedures and sequences worked out at the time of their first successful operation. Great economies and more versatile yarns, however, have resulted from an almost endless succession of refinements and simplifications.

SCIENTIFIC DEVELOPMENTS IN CELLULOSE CHEMISTRY

Scientific developments in cellulose chemistry, shown in Fig. 4, failed to keep pace with the technological advances; thus, cellulose processing, while being an established industry by 1920, was very much an art. Prior to this time little was known relative to the complex structure of cellulose and practically nothing had been developed in the general field of polymer chemistry. It is interesting to note that, in 1923, when Clifford reviewed the literature relating to the acid hydrolysis of cellulose, he was unable to conclude from the research over the preceding 58 years whether or not "hydro-

cellulose" had a definite chemical composition. This indecision led to the use of terms such as "hydrocellulose" and "oxycellulose" to describe the products of acid hydrolysis and of oxidation of cellulose, respectively. Such terms implied a specificity which subsequent work showed to be unwarranted. These early misconceptions have been resolved by the rapid advances in scientific knowledge over the past 30 years, although the terms themselves have persisted until the present. Thus, the important scientific literature is of relatively recent origin in contrast to the maturity of cellulose technology.

Fundamental research in cellulose has not only been successful in elucidating the chemical and physical structure of the fiber but, at the same time, it has laid the cornerstone of the rapidly expanding polymer industry. The first real milestone along the road to cellulose knowledge developed in 1920 from the application of x-rays to the study of fiber structure. These investigations showed that cellulose fibers were a composite of ordered and disordered regions, and initiated the extensive studies of crystallinity. These studies were successful in delineating the polymeric structure, in explaining the mechanical properties of fibers, and in revealing what physical attributes of polymeric systems are responsible for fiber-forming properties.

The development of the primary-valence chain theory of cellulose polymers was the next and possibly the most important guidepost to complete understanding of cellulose chemistry and to the development of polymer theory in general. This development was not the result of the individual effort of any one research school but rather the summation of the knowledge of many. Freudenberg's degradation of cellulose to cellobiose, Haworth's elucidation of the chemical structure of cellobiose, and Staudinger's studies led to the postulation that cellulose was composed of glucose units joined through beta-glucosidic linkages to form a linear polymer. The concurrent determination of the unit cell dimension by Meyer and Mark when amalgamated with x-ray information led to the enunciation of the modern fibrillar theory of fiber structure by Frey-Wyssling and Kratky early in the 1930's.

It was the concept of crystallinity in linear polymers and its relationship to strength and elongation which guided Carothers in his initial polymer investigations which culminated in the development of the so-called "miracle fibers" of today.

Research in the period of 1930 to 1940 was directed toward testing, proving, and modifying the initial hypotheses which were the outgrowths of the two major advances of the 1920's. This work led to the investigation of the reaction mechanism and reactivity of cellulose during derivative formation. This phase of investigation is being continued actively today both in industrial laboratories and academic institutions such as McGill University.

In the early 1940's, chemists became intensely interested in applying a number, or series of numbers, to cellulose which would express the degree of crystallinity of the fiber in a quantitative fashion. It became apparent, however, that the concept of a definite line of demarcation between a crystalline and noncrystalline area in the fiber was inadequate and incorrect, with the result that the fibrillar structure theory of today includes the concept that order is a statistical effect with no sharp lines of change, and that no one region is all order or all disorder.

Research during the 1940's was facilitated by the development and widespread use of the electron microscope. This instrument has confirmed the fibrillar structure of cellulose and has enabled investigators to measure the fibrillar dimensions and to identify the average number of chains which are associated in clearly defined crystalline regions of a cellulose fiber. The last decade also marked the development in the literature of some doubt concerning the uniformity of the cellulose chain molecule. Several publications proposed that weak links were present in the molecule and were responsible for variations in the rates of hydrolysis of cellulose in acidic medium. These ideas have been rather thoroughly rejected on experimental grounds by the majority of cellulose chemists, but the German workers, Husemann and Schulz, are still articulate proponents of the weak-link theory.

The current decade has also seen the development of a sound scientific knowledge directed toward a more thorough understanding of the stability of cellulose derivatives and of the mechanisms by which the normal stability can be improved. Much of this work is the outgrowth of industrial research rather than academic investigation. Major contributions to the basic scientific knowledge of polymers by industrial research are in marked contrast to other fields where the basic scientific information is provided by academic research. This reversal of classic order may well be due to the impact of the tremendous increase in industrial research over the past 15 years on what is still a very young field of investigation—high polymers.

The future of cellulose research is today as challenging a field as ever. Our knowledge has broadened tremendously over the past 20 years, but there is still far more theory and postulation than well-established fact in cellulose chemistry.

CONCLUSION

The literature spectrum of cellulose chemistry shows it to be the most important single contributor to the development of our scientific knowledge of polymer chemistry and to our technological advances in the fields of communications, plastics, protective coatings, fibers, and photography. An indication of the impact of cellulose research on these many fields is the universality and diversity of cellulose literature. A projection of the spectrum delineated in this paper upon that of science as a whole reveals that cellulose research is an integral part of the world-wide literature in the fields of organic chemistry, physical chemistry, physics, and engineering. Beyond this, it has assumed a major place in the recorded history of the world, upon whose pages are written the interplay among man's creativity, his problems, and his environment.

The Path of the Searcher in the Literature

G. J. C. POTTER

THE five preceding papers of this symposium (*1–5*) have drawn a comprehensive map of the general field of the literature of cellulose and related materials. The aim of this paper is to describe how this map can be used to locate specific information. It attempts to do so systematically, in the belief that systematic searching offers the advantages of securing the literature more certainly, saving time, and avoiding needless repetition—advantages which are particularly valuable in searches carried out as parts of specific team projects, and hence limited as to time, field, and completeness. Since the literature of cellulose is a very broad subject, the system of search suggested here may of course fail of universal agreement. It is nevertheless presented with the idea that even partial realization of the above advantages is worth while. The suggested system will therefore be described first in principle, and then illustrated by examples of its application to searches in various categories of the cellulose literature.

PRINCIPLES

The Topography of the Literature

Let us take a quick look again at that imaginary map of the

G. J. C. POTTER, Pulp and Paper Research Institute of Canada, Montreal, Que.

literature. We see represented on it publications of two rather different kinds. First are the primary items themselves, as published originally in papers or patents, and as successively condensed into abstracts, reviews, and books. As far as this material is concerned, the journals which contain it form subjectwise a sort of patchwork with ill-defined borderlines (*1*). Inside this patchwork the neophyte can make out faint trails, formed by the existence of references, in most of these items, to some earlier items on the same subject. But neither patches nor trails are sufficient, by themselves, to show the searcher where to enter the patchwork in the first place nor, if he does stumble on an entrance, how to find all he wants. It is to serve these functions that the second component of the literature has been erected—the secondary or "guidepost" material, i.e., the catalogs, indexes, and bibliographies which list the titles of the primary items in one or more definite orders, and give their location. The two main orders used are (1) alphabetically by the author's name, and (2) alphabetically by a selected list of subject headings. In selecting a method of search, therefore, the searcher has a certain amount of choice as to the sequence in which he will use the various existing indexes, and the manner in which he will enter them.

Methods of Search

Generally speaking, there are two fundamentally different ways of searching for almost anything. These are (1) taking a succession of quick stabs at it; and (2) first bracketing it, and then systematically closing in. With luck, the first method can be very quick; without it, one can go on stabbing forever, without necessarily getting any closer to the target. The bracketing method, on the other hand, by excluding the indefinite failure as well as the lightning solution, often results in a lower *average* searching time. As applied to literature searching, these two general methods are represented by two alternative methods of entering the indexes—the "author's name" method corresponding to the quick stab, and the "subject heading" method corresponding to systematic bracketing.

The "Author's Name" Method

In the "author's name" method, the searcher enters the author index, usually in an abstract journal, with names of persons understood by him to be active in the field of the search: he thus finds items in the field, which refer back to previous items . . . and so on. In this way he is—theoretically, at least—led directly back to the most important items in the field, no matter when or where they were published. However, this method in effect relies on the literature searches which these authors themselves have made, and there is no guarantee that they did not miss pertinent material; for example, the epochal researches of Avogadro, Gibbs, and Mendel all went unnoticed for years by workers in the same field (*6*). By this method, therefore, the searcher finds it very difficult to estimate the completeness of his own search at any stage; nor has he the assurance that he is necessarily getting any closer to his goal as he continues searching. The fact that the "author's name" method usually leads immediately to original papers or patents, gives it another disadvantage in unfamiliar fields, since in this way the searcher may be presented with his information without the background which would enable him to view it in proper perspective. The "author's name" method may, therefore, save time, but it is only for those closely familiar with the subject field and its personalities. Even then, when completeness is important, it needs to be checked by a subject heading search.

The "Subject Heading" Method

The "subject heading" method differs from the "author's name" method first of all by commencing with the careful preparation of a list of subject headings. Entering the comprehensive indexes with this list then makes possible a systematic enveloping movement from the general to the particular through the successively less general levels of books, reviews, abstracts, and original material. In this way the searcher should not only have to scan, *on the average*, a minimum of material in locating his objective, but should find it through its background, and hence be in a better position to judge its import and reliability. He need start, of course, only so far back in the general as his unfamiliarity with the field demands, and need proceed into the particular only so far as the nature of his information requires.

However, let us for the purpose of description discuss the full range. It would be most convenient if there were one index peculiar to each of the four levels of generality into which we have divided the literature. However, existing comprehensive indexes actually fall into three types which overlap in the levels to which they refer: (1) the catalogs of libraries which are virtually complete in their fields (to books and separately published reviews); (2) indexes to abstracting periodicals (to books, reviews, abstracts, original material); (3) recurring bibliographies (to books, reviews, original material, and sometimes to abstracts).

Despite this overlapping, however, these indexes have characteristics which suggest the order in which they should be used. Abstract indexes and recurring bibliographies, due to the limited time interval to which each volume refers, are not usually as convenient for locating books as a large library catalog. And since recurring bibliographies cover particular fields and give titles of papers directly, they are often convenient to use prior to the abstract index, even though the latter may have to be used later anyway to locate the abstracts. Consequently, the ideal order seems to be: (1) library catalog, (2) recurring bibliography, (3) abstract index. The overlapping of these indexes makes it essential to record references, as found, on separate cards, so that they can subsequently be sorted as to condensation level, and the material to which they refer read in that order.

The "internal trails," i.e., the pertinent references found in the bibliographies of the books, reviews, abstracts, and original material as they are read, will of course be recorded and read also.

Such a system of search demands a decision as to the period of time which the search is to cover. Since speed in searching is increased by mining the richest ore first, and since, unless anything is known to the contrary in a particular field, the most modern material is the most valuable, the search should usually start at the most recent literature and work back. The question of "How far back?" is usually determined by the rate at which the yield of references falls off, and the length of time available for the digging or search itself.

The outline of such a systematic search will therefore look something like this:

1. The preparation of a subject headings list.
2. Library catalog—for books.
3. Books.
4. Recurring bibliography.
5. Abstract index.
6. Reviews.
7. Abstracts.
8. Original material.

(3–8) ⇌ Additional references

PRACTICE

The application of this scheme in detail to a given search will depend chiefly on the recurring bibliographies and/or abstracting services which exist in the particular field. Before starting the search proper, however, an important prerequisite must be taken care of, i.e.,

The Establishment of the Frame of Reference

This involves decisions on the following points (which, in the case of team research, can only be arrived at in a team conference):

1. The question which the search is expected to answer, together with its technical purpose and background.
2. From this, the lists of subject and author headings (to which the laboratory researchers will contribute their knowledge of the scientific field, and the literature searcher his knowledge of classification systems). Since invariably, during the actual search, some of these headings will yield no pertinent references and should be deleted, while new headings found through cross reference will require searching back, these lists should be made in writing and carried forward for checkoff.
3. From these headings, an estimate of the time which the search will take—which may have to be compromised against the time available on over-all considerations.
4. Hence, the degree of completeness with which the search will be carried out.

The Literature Search Proper

Now the searcher must decide whether his search lies in (1) the literature of a background science, (2) the periodical literature of technology, (3) the patent literature, or (4) the market literature, for these differ as to the bibliographic tools available. Broadly speaking, the fundamental and background sciences are each served by a comprehensive abstracting service—e.g., *Chemical Abstracts*, *Science* (*Physical*) *Abstracts*, *Biological Abstracts*, and the *Engineering Index* (*2*). However, though these abstracting services also cover the related technologies, they are not—because of their very comprehensiveness—good places to start a search in a particular technology or trade, if a more specialized abstracting service or bibliography is available (*4*).

The Literature of the Background Sciences. Let us see how these considerations work out in some specific examples, taking first a search in the literature of background science, say on "The Accessibility of Cellulose." First of all, this is defined as the percentage amount of a given cellulose sample that combines with a specified reagent under standardized conditions—this amount often being calculated from the rate of the reaction. The rate of reaction is partly governed by the extent of colloidal surface offered, and hence involves the chemistry and physics of surfaces; it also depends upon which group in the cellulose is reacting, and the substance with which it is reacting.

From these considerations the list of subject headings is developed. The chief one will be "Cellulose," with the following subheads: accessibility, activation, cellulose compounds or derivatives, hydrates, hydrolysis, morphology, and reactivity. Other main heads will be cellulose acetates, cellulose esters, cellulose ethers, cellulose nitrates, and cellulose xanthates. Main headings for the rate of reaction will be: activation, adsorption, esterification, etherification hydration, hydrolysis, micellar structure, morphology, oxidation, penetration, reactivity, sorption, surface chemistry, swelling, and topochemistry.

After gathering some background, if necessary, from books located by main headings, e.g., Ott's "Cellulose" and Heuser's "Cellulose Chemistry," the searcher will enter the *Bulletin of Institute of Paper Chemistry*, or *Chemical Abstracts*, with the heading "Cellulose" and the subtitles above, and pursue matters further if it seems warranted in *Chemisches Zentralblatt*, *British Abstracts*, the Abstract Section of the *Journal of the Textile Institute*, and the *Bullétin Analytique*. The list of headings beginning with "Activation" will be searched in *Science Abstracts* as well, to catch references of a purely physical nature.

The Technical Literature of an Industry. Now let us take, as an example of a search on an industrial process, "The Formation of Calcium Sulphate in the Sulphite Process." Our headings here will be, first of all, the potential parents of calcium sulphate—calcium, calcium compounds collectively and also, as separate headings, bisulphite, hydroxide, sulphate, sulphite, etc.; and sulphur, sulphur compounds, sulphur dioxide, sulphur trioxide. Secondly, the course of sulphur and calcium through the process will be traced through the headings sulphur melter, sulphur burner, sulphur combustion chamber, sulphite acid, sulphite process, and sulphite waste liquor.

The first step, if necessary, will be books such as "Pulp and Paper Manufacture" (*3*), for background. The next step will differ, however, from the fundamental search above, in that we will take advantage of the technological "West's Bibliography of Pulp and Paper Making" and search the above headings there first, before locating the corresponding abstracts in *Chemical Abstracts* or—more conveniently after 1930—in the *Bulletin of the Institute of Paper Chemistry*.

The Patent Literature. In the general field we are discussing, patents are so well organized in the ordinary periodical technical literature that an information (as opposed to a legal) search can follow the above general procedure; the only difference being that more foreign indexes must be searched, since foreign patents are not usually covered as thoroughly on this Continent as are foreign papers. Let us take a search for patents on "The Bleaching of Pulp with Per-Compounds" as an example.

Here the headings will be: bleaching, paper pulp, per-compounds collectively, and a list of individual per-compounds (most conveniently found in a chemical encyclopedia or dictionary). Since bleaching agents for textiles are also applicable to paper pulp, textiles of all kinds should also form headings.

Books to be consulted for background will be TAPPI Monograph No. 10, "The Bleaching of Paper Pulp" and Trotman and Trotman's, "The Bleaching, Dyeing and Chemical Technology of Textile Fibres." Relevant U. S. patents for bleaching pulp after 1926 will be covered by West; before this, and for textiles and per-compounds, *Chemical Abstracts* will serve. To be sure of complete coverage of foreign patents, the abstract section of the *Journal of the Textile Institute*, *British Abstracts*, *Chemisches Zentralblatt*, and *Chimie et Industrie* will also be searched. Finally, the *Journal of the Society of Chemical Industry*, *Chemisches Zentralblatt*, and *Zeitschrift für Angewandte Chemie* will provide 19th century patents.

The Market Literature. The territory covered by market literature shifts to exclude fundamental science on one side and to include economics on the other. Insofar as this material appears in periodical form, the *Industrial Arts Index* is probably the most useful starting point. Much also appears in pamphlet form and, for locating such material, indexes like the *Public Affairs Information Service* exist. Sources of raw data are the periodic statistical reviews of the cellulose industries put out by trade associations, national bureaus of statistics, national departments of trade and commerce, and the United Nations.

Recording the Results of the Search

After the search is finished, one important step remains—recording its findings. To realize the full value of the searcher's efforts, the form in which this is done must suit both the purpose of the search and (in teamwork) the familiarity with the subject of the literature searcher who makes the report, and of the laboratory man who receives it. The report can vary in form from a reading list for the background orientation of a team, to a technical brief in answer to a specific question. Such material as requires more technical analysis than the literature searcher can give may need to be attached in its original form to the search report. In any case the reader of the report should never have to retrace the searcher's steps in order to complete the purpose of the search.

LITERATURE CITED

1. Hearon, W. L., "Publications in the field of cellulose and related materials," *Tappi* 37, No. 9: 152A (Sept. 1954).
2. Brown, Curtis L., "Abstract services covering the chemistry of cellulose and related fields," *Tappi* 37, No. 9: 152A (Sept. 1954).
3. Jahn, E. C., "The literature in the field of cellulose and its related materials—its definitive literature," *Tappi* 37, No. 9: 168A (Sept. 1954).

4. Weiner, Jack, "Available bibliographies in the cellulose, pulp, and paper fields," *Tappi* 37, No. 9: 174A (Sept. 1954).
5. McBurney, L. F., and Skolnik, Herman, "Historical developments of cellulose and wood literature," *Tappi* 37, No. 9: 190A (Sept. 1954).
6. Smith, Julian F., "Literature's buried treasures." (Paper presented to the Division of Chemical Literature, American Chemical Society, 125th National Meeting, on March 31, 1954, at Kansas City.)

A Tribute to C. J. West

E. J. CRANE

A USEFUL man helps others as he helps himself. Very few chemists have lived a more useful life than did Clarence J. West. He did a prodigious amount of work during his many active years, and his tasks were usually ones affecting the general good. What could be more unselfish, for example, more helpful to fellow scientists, than West's work for *Chemical Abstracts* during more than 40 years?

I shall speak first of West's work as an abstracter. He earned the title "Mr. Abstracter" by accomplishing what has seemed well-nigh impossible. Working at abstracting merely as a spare-time activity West made almost a thousand abstracts per year during more than 40 years. His assignments were not easy ones and yet he steadily led the field in productivity, maintained a high standard of quality, and earned a reputation for dependable promptness. He worked always with terrific speed and intense concentration, and his efficiency was uncanny.

I once had the pleasure of visiting "C. J." in his home, then in Washington, D.C., and saw his abstracting workshop. It was a little room with a typewriter desk in the middle and shelves within reach on three sides. West is said always to have done the work of two men on his regular jobs and then to have spent a large portion of the rest of his time at his abstracting desk doing the work of at least two more men. He did his own typing and wrote his abstracts once only with almost no need for erasure. It was always a pleasure to edit C. J. West abstracts because they needed so little attention.

During the period 1923 to 1941 West was co-editor of the large section on organic chemistry in *Chemical Abstracts*, his colleague being Charles A. Rouiller, who is now in his 48th year of work for *Chemical Abstracts*. As was West, Rouiller is a giant in abstracting and editing work and I know that West would like having Rouiller mentioned as his colleague in *C.A.* work. Rouiller was his friend and his strongest rival in productiveness.

West was primarily an organic chemist. His first after-college work was organic research at the Rockefeller Institute under P. A. Levene. "C. J." studied at the University of Michigan under the guidance of Moses Gomberg. Both of these supervising gentlemen required good work and one can be sure that West would have been an excellent laboratory man all his life if he had stayed in this work.

West's determination to help directly during World War I changed the course of his life. As has been pointed out by Louis E. Wise, West's colleague both at The Institute of Paper Chemistry and in abstracting work, Levene opposed enlistment of his workers in the Army and said: "If any one of you men leave me, I don't want you back when the fighting is over." West enlisted nonetheless and left the Army at the end of the war as a Major in the Chemical Warfare Service. With Amos A. Fries he eventually wrote a book on chemical warfare.

I have never known why West did not go back to laboratory work, but I think it was a case of a man's avocation becoming his vocation. He had to be fond of abstracting, editorial, and similar work to do so much of it so well. This was fortunate for chemistry. Surely much more has been accomplished at the laboratory bench because of West's efficient hard work with chemistry at a desk than he could have matched by other than the most phenomenal research results.

This tribute is not meant to be a biography, at least by no means a complete one. I shall not attempt to describe what West accomplished when with A. D. Little, Inc. in Boston (1919–21), where he became interested in paper chemistry, what he did on the staff of the National Reasearch Council (1921–36), where he edited a series of Annual Surveys of American Chemistry and International Critical Tables, or what he did so well at the Institute of Paper Chemistry in Appleton, Wis., where he spent the last years of his life, from 1936 until his death, on Jan. 29, 1953. At Appleton he turned out many monographs and an almost endless number of bibliographies on pulp and paper while modestly and selflessly doing many other tasks with acumen and driving energy.

I find myself wanting to come back to West's work for *Chemical Abstracts*. It is in this connection that I knew him best.

Soon after West became interested in paper chemistry, in 1919, he began abstracting in that field as well as in organic chemistry, and in 1922 he assumed editorial charge of the section on "Cellulose and Paper" in *Chemical Abstracts*. This work was continued until his death.

I have been told that an hour before C. J. West died he asked the nurse to prop him up in bed, called for a journal and proceeded to work on an abstracting assignment. Another sign that he was active in *C.A.* work up to the end is to be found in the fact that in the number of *Chemical Abstracts* in which a brief obituary of him was published (the Feb. 10, 1953, number) the whole section of organic Chemistry (74 pages—patent abstracts excepted) was devoted to his abstracts. As if by premonition this was arranged as a tribute to a marvelously productive old-timer even before we knew of West's illness. Now I like to think of it as a sort of memorial to a devoted and extremely helpful colleague, who was also my friend.

In spite of all else he did "C. J." found time for gardening, which he loved, and for both Masonic and Rotary Club work, into which he went with characteristic high interest and vigor. Much more important, he found time for his family. After his father's death C. J. West, Jr., wrote me to say: "Dad was indeed a great man and was my closest friend. In spite of his devotion to his work, of which *Chemical Abstracts* was a vital but small portion of the total, he found time to give me all the love and time that I would accept." What could be more important than to be a great man in the eyes of one's grown son?

"Go West, young man" was advised in the Terre Haute, Ind., *Express* in 1851 by John Babsone Lane Soule. This expression attracted others, such as Horace Greeley and James J. Hill, as very good advice during the years when America was rapidly growing westward. They repeated it. I find myself wanting to offer this advice to young men of today with a new meaning. I am not thinking so much of the growing appreciation of the value of work in the field of scientific literature and of the opportunities there, even pioneering opportunities, but rather I am thinking principally that I offer good advice in the sense of suggesting modeling after the life of C. J. West when I say "Go West, young man." Those who followed Soule's and Greeley's and Hill's advice by facing and moving west often found golden opportunities and saw glorious sunsets. He who is wise enough and able enough to follow in the footsteps of C. J. West, not step by step, but by trying to measure up to the stature of the man, will find golden opportunity for a full and useful life, and surely he will catch glimpses of things glorious.

E. J. CRANE, The Ohio State University, Columbus 10, Ohio.

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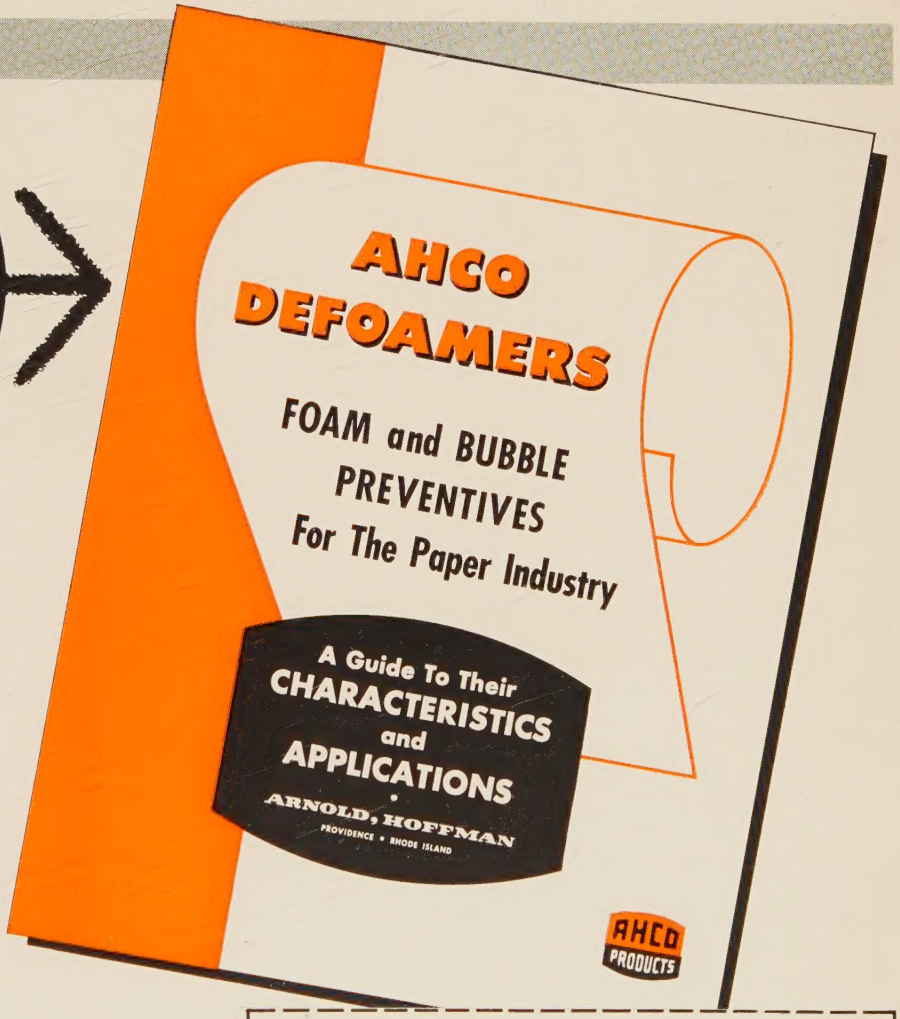
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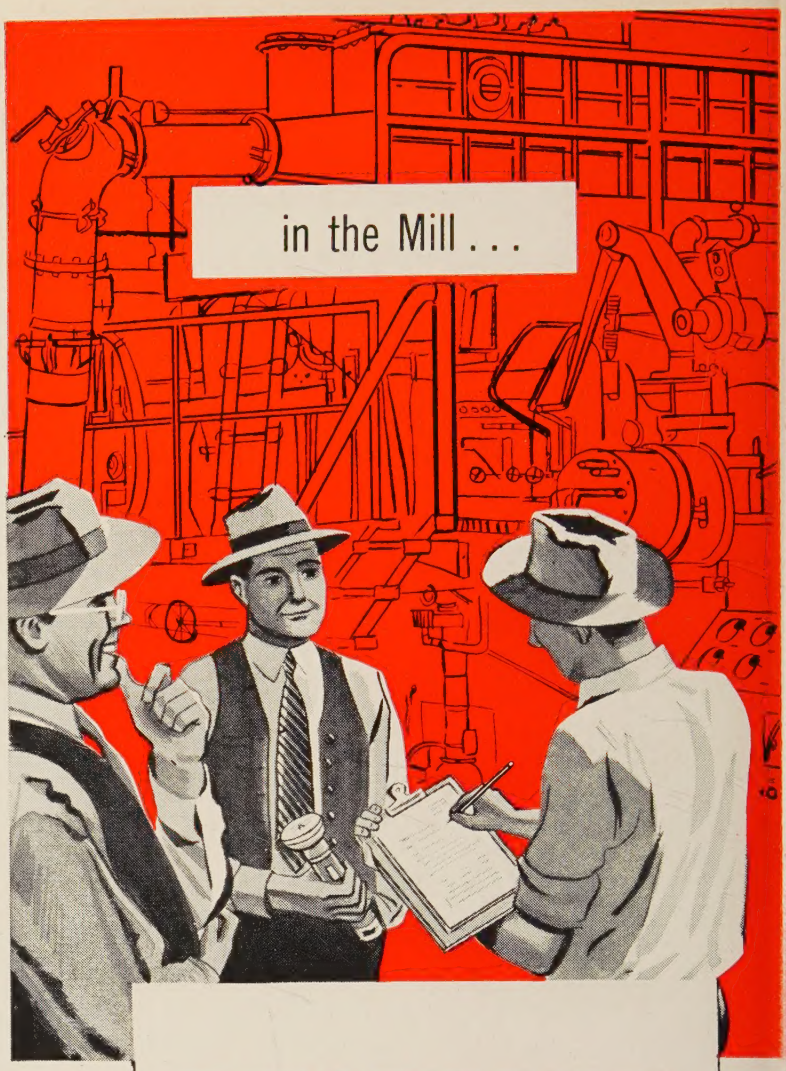

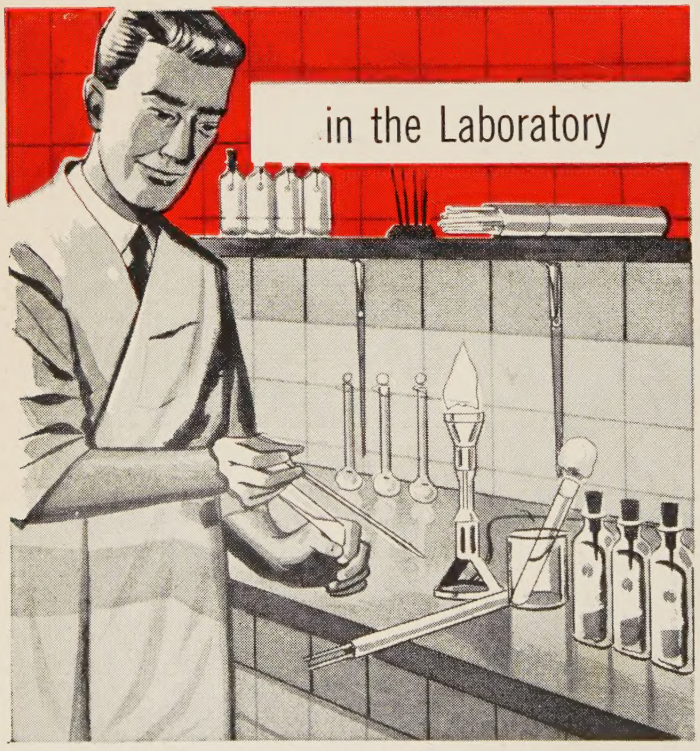

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